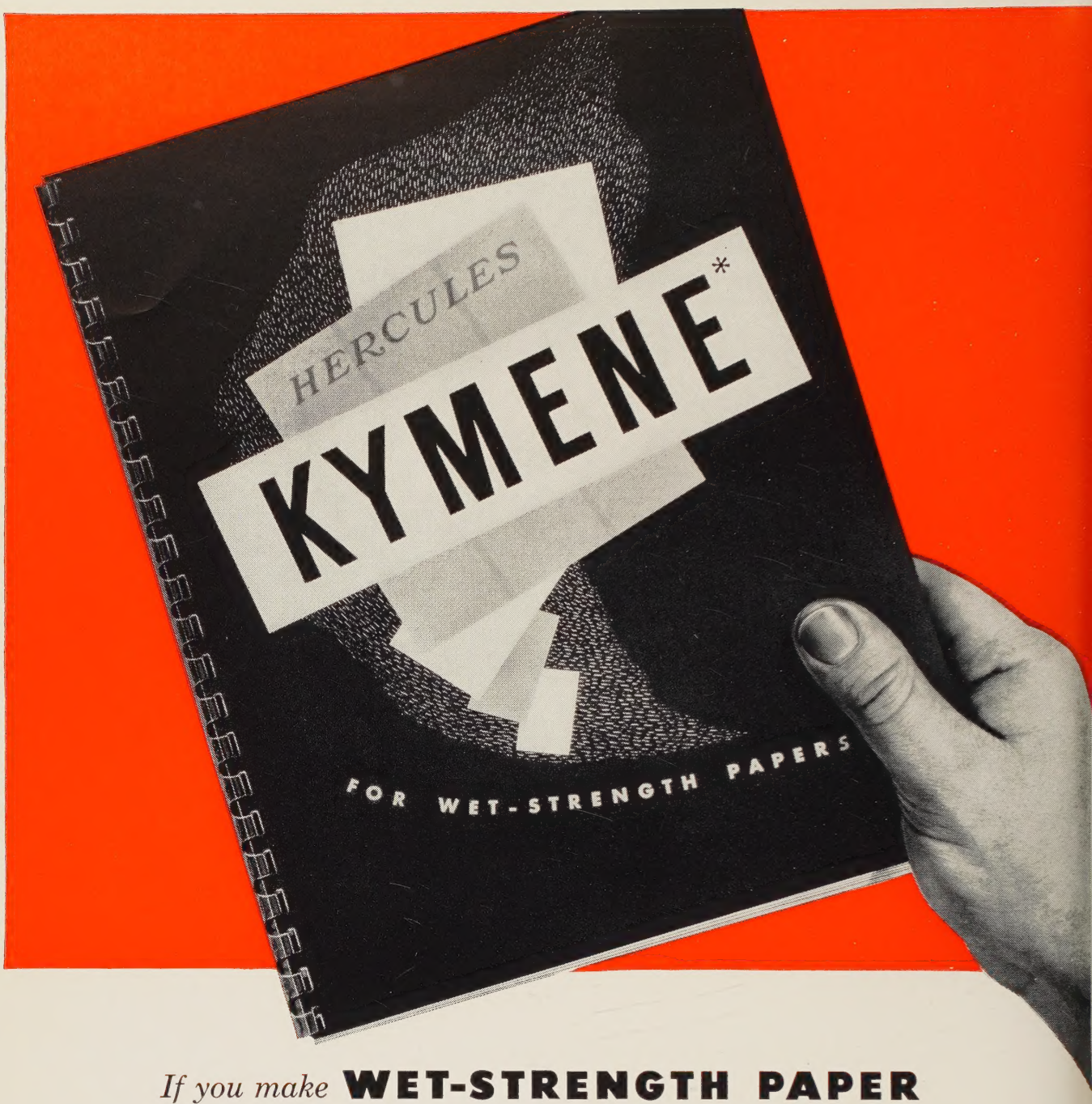
Tappi

PUBLISHED BY THE TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY

MARCH 1953



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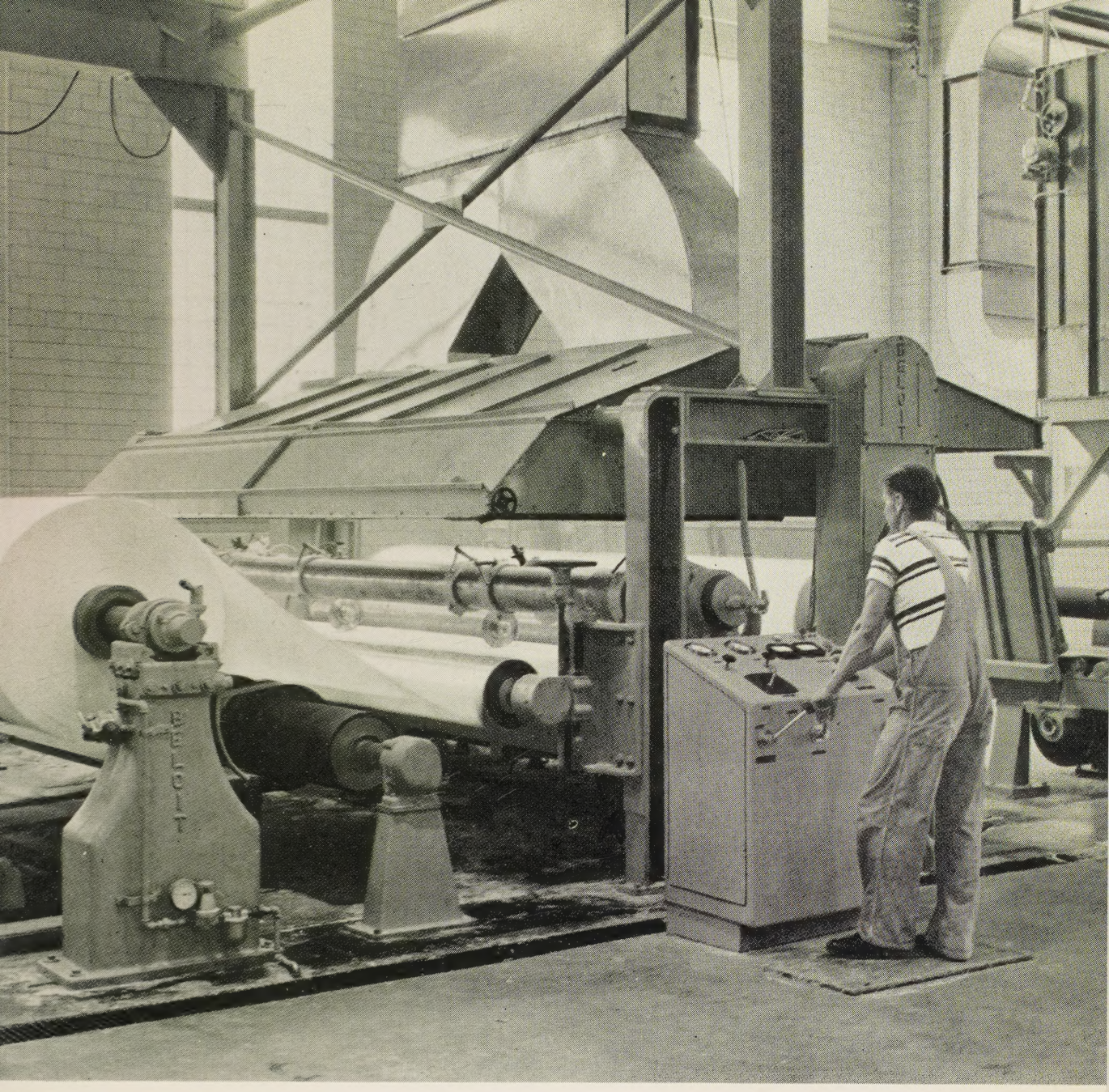

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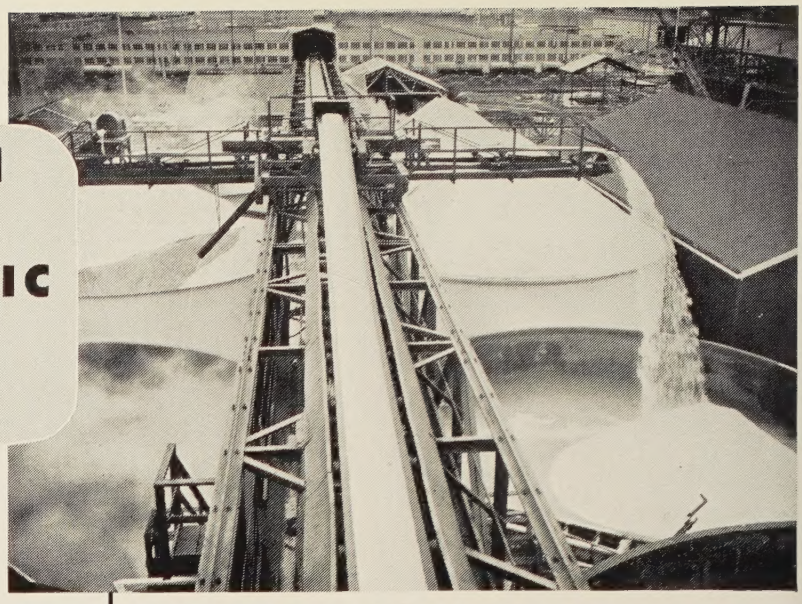

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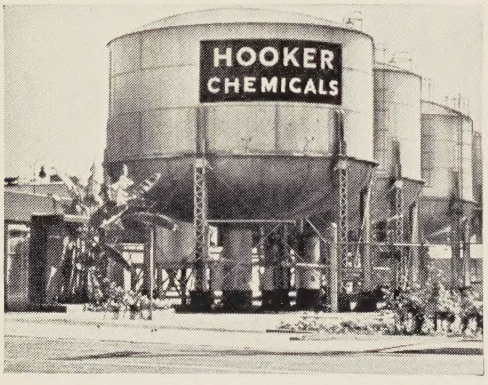

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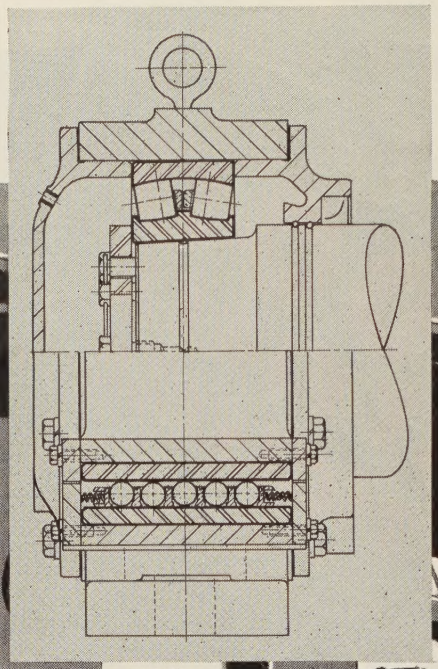

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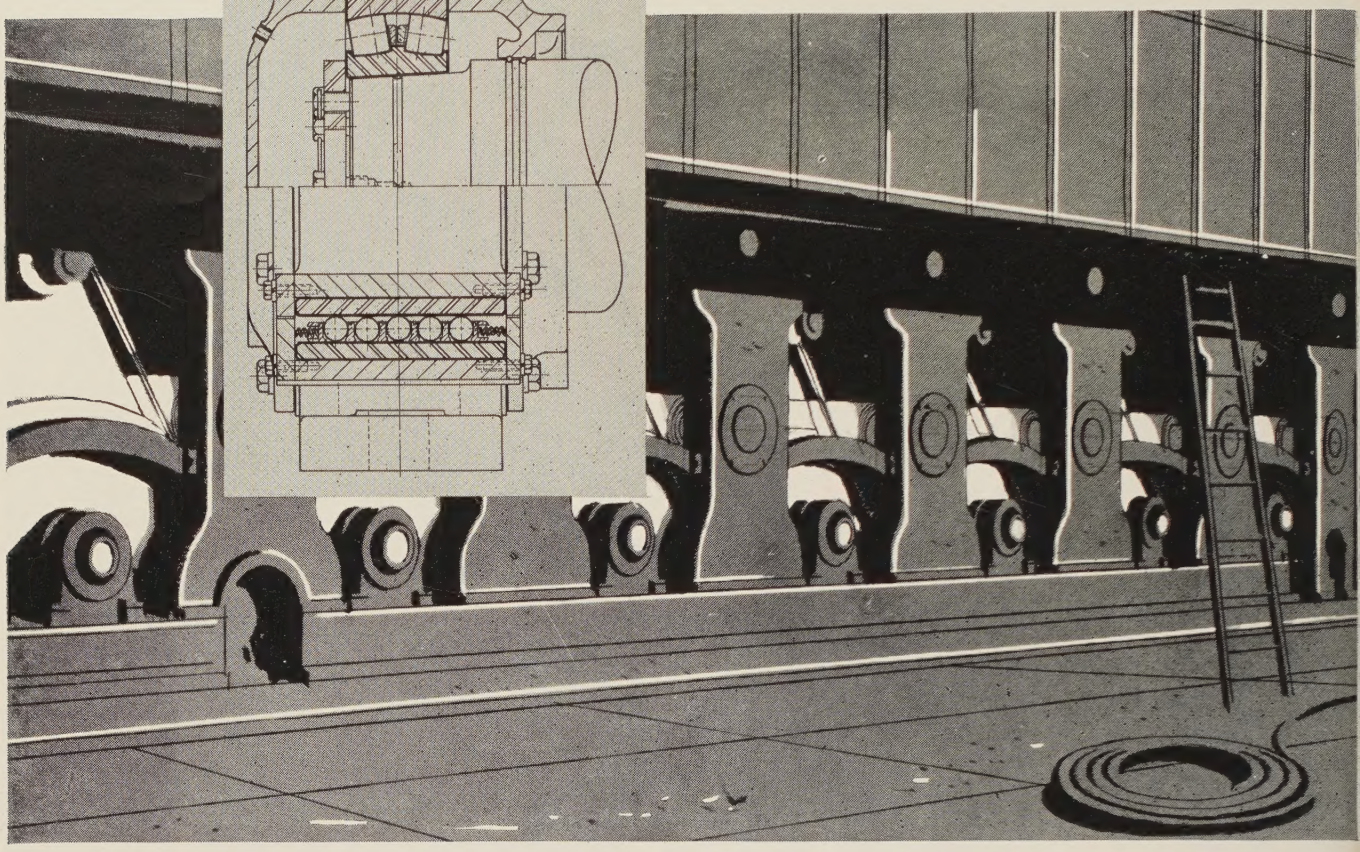
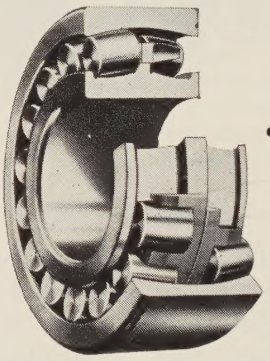


Cutting costs from



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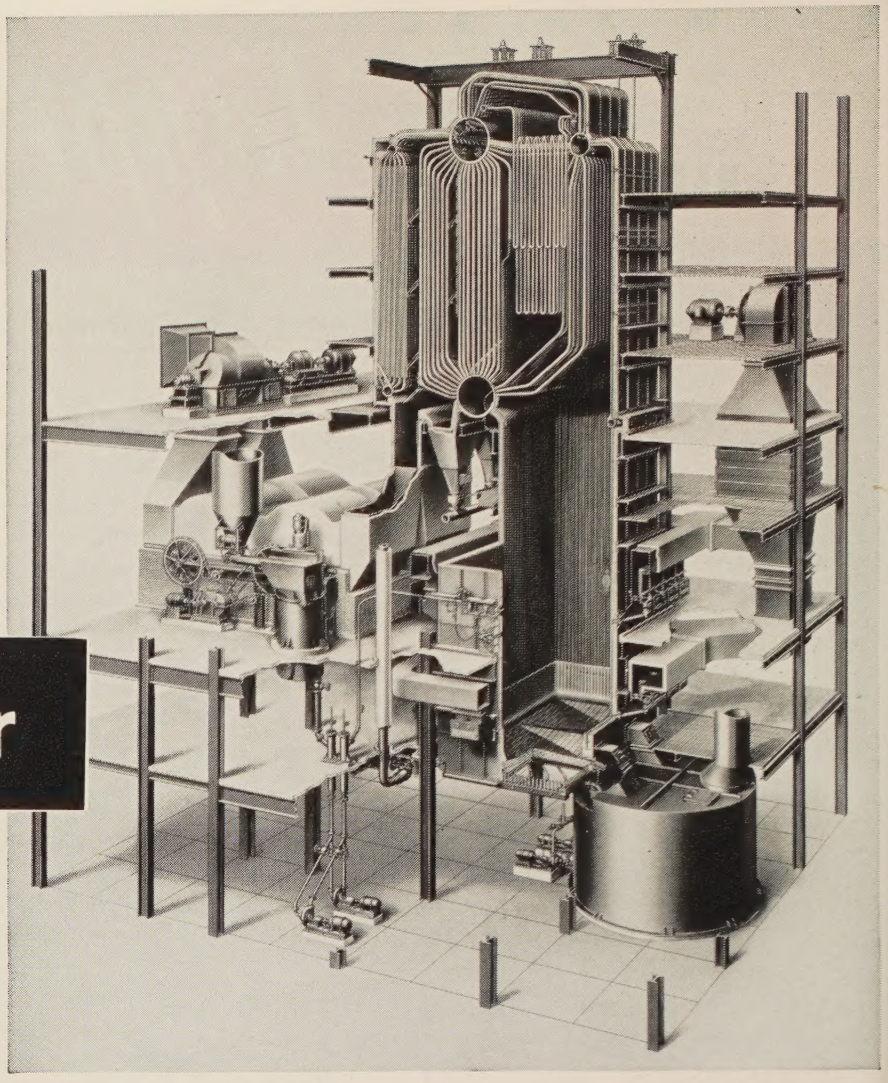

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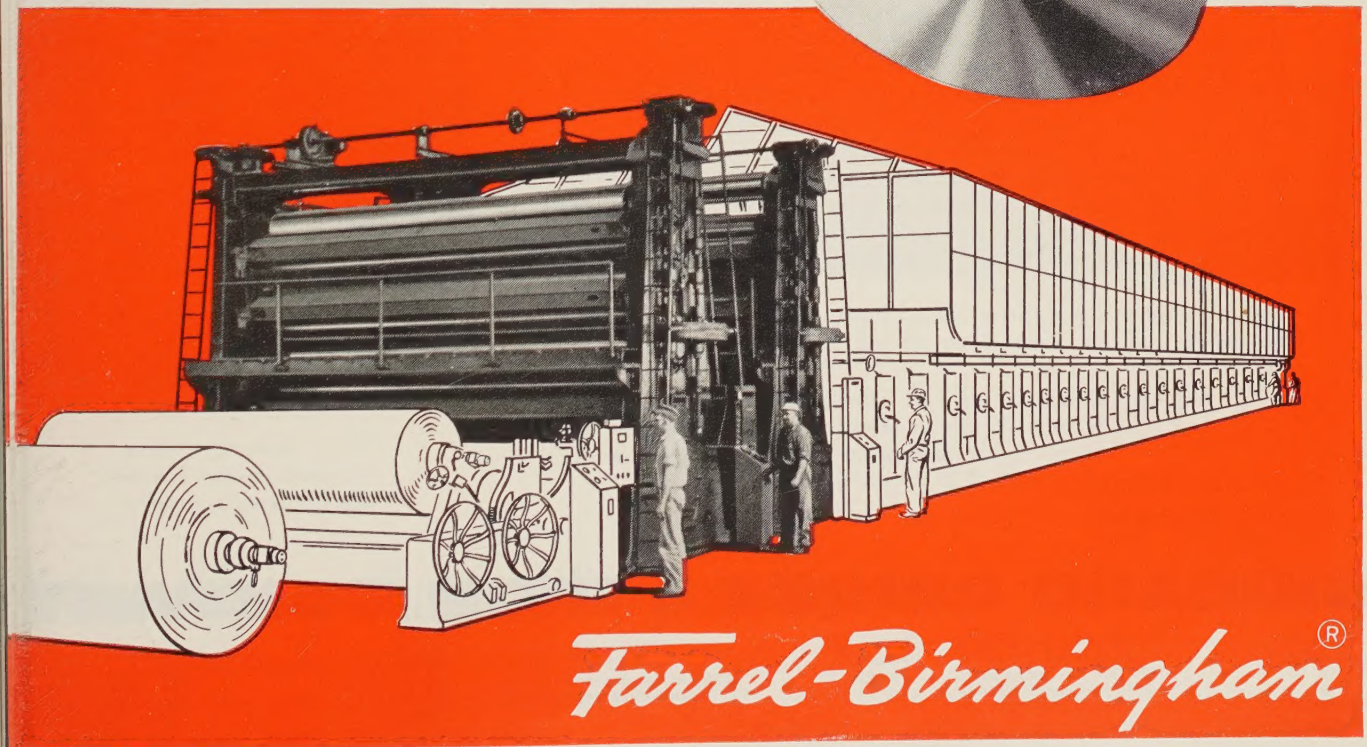

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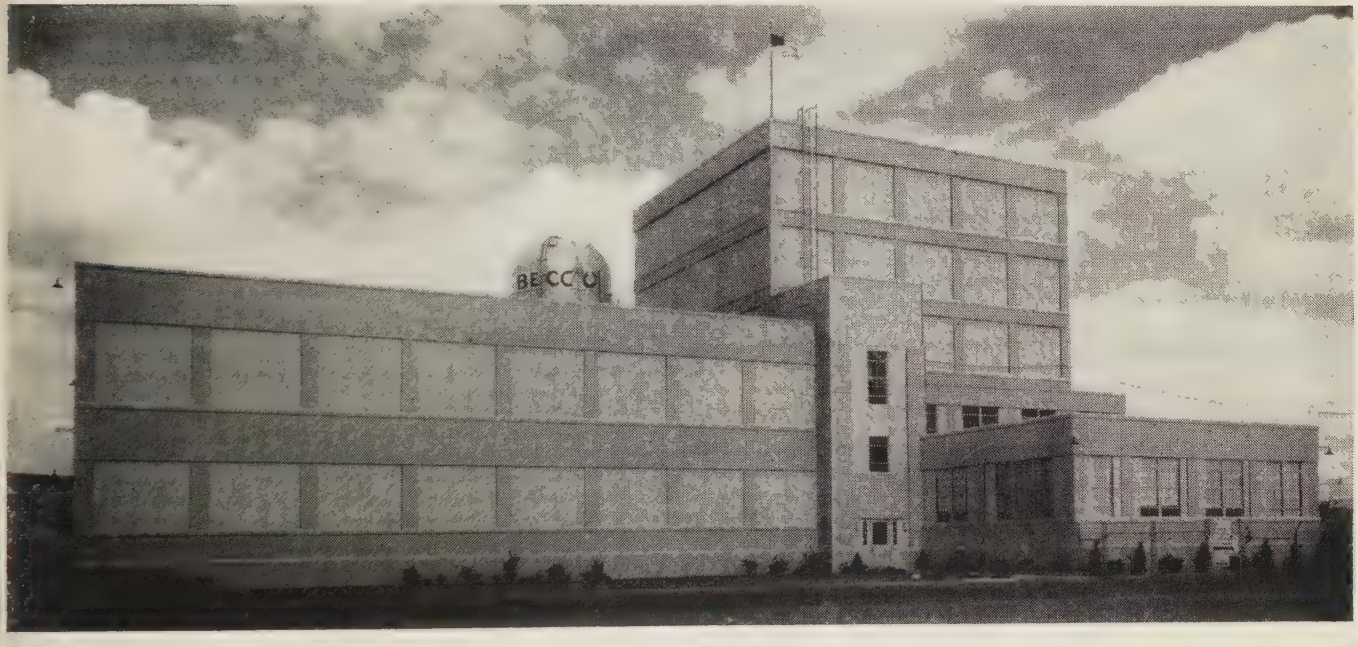

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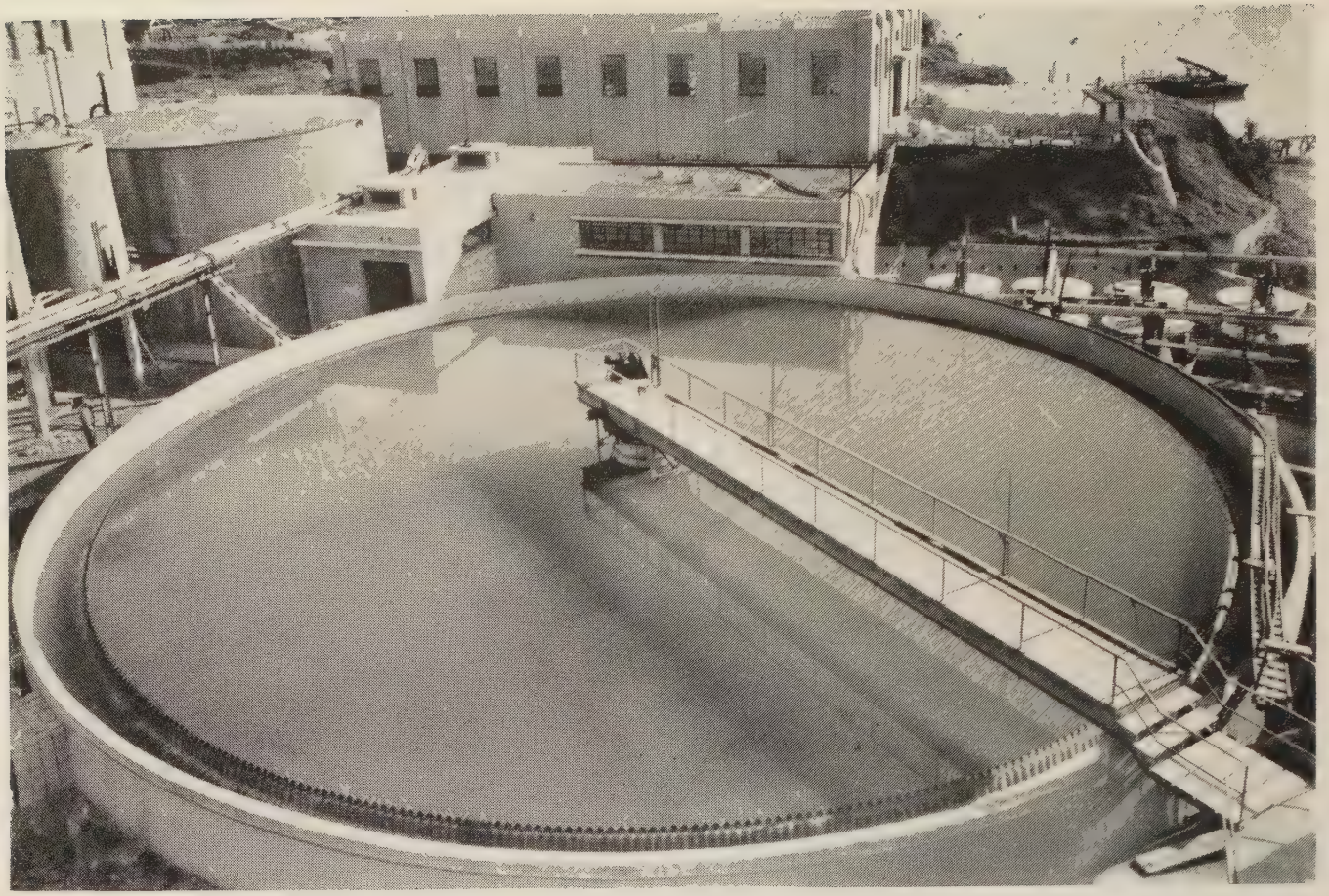

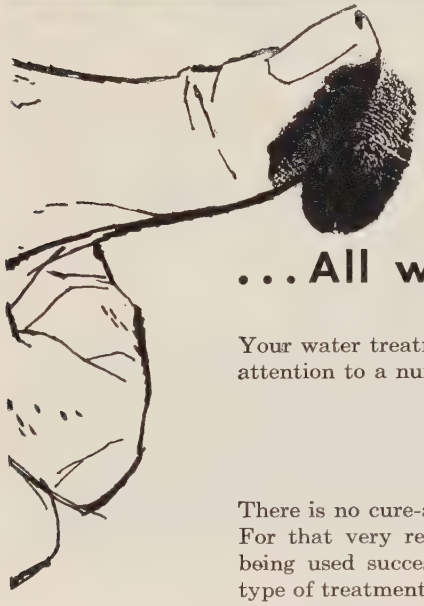

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type of treatment
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ADDRESS OF THE PRESIDENT

NEXT Thursday, February 19, will end nine years during which I have had the privilege of serving you as a member of the Executive Committee and as an officer of National TAPPI; and there are a number of things that I would like to tell you at this time.

But first I wish to thank you for the privilege that you have given me; it has been one of the greatest experiences of my life. Also, I wish to pay tribute to the loyalty and unselfish effort of the men that I have seen working for you as members of your Executive Committee.

Their devotion to your interest is something that one has to see to appreciate; but I hope to give you a personal picture as I have seen it. Also, I would like to tell you some of the recent developments that have been taking place in National TAPPI and some of the problems the Association is facing.

When first I was asked if I would serve on the Executive Committee, I will confess I accepted with a feeling of curiosity about its duties, its attitude, and how it reaches its decisions. Many of you must be curious too; but your interest should be more than curiosity and more than your personal interest in TAPPI, as it is a matter of concern for your future and for that of your company. Let me explain what I mean.

When I was introduced to the paper industry over 30 years ago, the technical men were groping through a maze of unknown relationships in an industry that seemed to cherish a pride in the fact that it was more an art that a science. Several progressive companies had developed technical departments for control and research; but many were without technical help of any kind. Some mills had "a chemist"; most engineering was done by consulting firms; and most mill managers would have laughed if you had suggested that they would find a physicist helpful.

Even then, there were mill managers who could not believe that a man in a laboratory could tell you how much rag was in a sheet of paper. pH was still a mysterious term; and I can remember trying to explain it over the long distance telephone. Sulphate pulp could not be bleached satisfactorily and most paper machines had the old fashioned couch rolls. The fast running paper machines, as we know them, seemed as wild a dream as some of our ideas about space ships.

Consider the difference today. All progressive mills have large technical staffs; and those companies best equipped for research, engineering, and quality control are the ones that realize the largest profits and are in the best position competitively.

Some of this change can be attributed to natural development; but I know all of you will agree that the progress could not have been half as great without the information that has been gained and made available through TAPPI.

It is evident that the future of your company and the future of you as an individual connected with the paper industry depend upon a continuation of the progress that has been made in the past. It is also evident that it is of paramount importance that TAPPI continue to contribute toward that progress.

So let us consider for a few minutes the factors that have made TAPPI's contributions so valuable.

Although many good books have been written on the manufacture and the characteristics of pulp and paper, the real literature of the industry is to be found in papers presented at meetings, in magazine articles, and in books on specific subjects.

In the entire industry no source of information compares with that of the TAPPI publications. The papers presented at our meetings are prepared by members, with the backing of their companies, who give the Association time and talent far beyond what anyone could purchase. The monographs prepared by our committees summarize in less detail but in a readable form what is known about specific phases of papermaking. Our all-important bibliographies permit the investigator to locate original articles on any subject, and prevent these important articles from being overlooked and lost in the great volume of published material.

More and more in recent years, papers presented at our local sections have been such as to merit National attention; and our new magazine *Tappi* is making these available to the entire membership.

Every member can appreciate the amount of work that these represent. Here he has direct evidence of the tireless efforts of our technical committees. Not so evident, but equally important is the work of the National organization that makes all of this possible.

As all of you know, the National organization consists of two groups, the permanent employees in our Association offices in New York, and the Executive Committee including the officers. The latter is the governing body and determines the broad policies.

Our Secretary and his staff are responsible for the actual administration, and it is to them, especially to Mr. Macdonald, to whom we should give the greatest credit for the success that TAPPI has achieved. On December 1, Mr. Macdonald completed his 25th year as Secretary of our Association.

The efficiency with which they have handled the affairs of our organization, including the publication of our new magazine, with such a small staff is something at which I will never cease to marvel. I wish to pay tribute to the genius and untiring efforts of Mr. Macdonald, and to say again that we are indeed fortunate in having his leadership.

However, it is about the Executive Committee that I would like to tell you today, because you are less familiar with its duties and how it operates. I would like to do this on a very personal basis as one who is able to report to you directly some of the things I feel you should know about it.

You will remember that I said that I was curious about this group and what sort of attitude I would find

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in its members. Certainly I did not anticipate all that I found.

My first impression was the length of the Executive Committee meetings that were held periodically throughout the year. These involved long tedious discussion on matters of policy during which the various members submitted opinions from all angles. I was much impressed by the fact an answer that appeared logical when the problem was first stated, often proved to be entirely wrong after all of the facts were considered.

Also, I was impressed that although each member supported his own view to a point where the argument often became heated, when the decision was reached on the basis of the majority's opinion, none of the members carried away from the argument any animosity or feeling that his idea had not been given proper consideration, nor would he hesitate to support just as strongly his own ideas on the next problem that was considered.

Later I began to see evidence of the amount of time and effort spent by these members between the dates on which the meetings were held—time that you wondered how they could afford and for which they received no reward other than the satisfaction of having done something for TAPPI.

I had heard rumors that "politics" entered into many of the decisions. I wish to say that I have been unable to find any trace of anything of that kind in all of the years that I have been on the committee. In fact, I remember one case particularly in which a member surprised me by suggesting an action entirely contrary to what his personal feelings must have been, and only because he felt that it was the fair thing to do.

It was after many of these long discussions that the new magazine, *Tappi*, was started. Dared TAPPI undertake it? Could it be printed and distributed without a large increase in membership dues? What kind of a magazine should it be? What kind of papers should be included? How should they be edited? The discussion continued for meeting after meeting. The magazine's success indicates that the final decisions were sound, although no one could anticipate Mr. Macdonald's genius in this field nor anticipate the tremendous amount of work he had contributed to make it so outstanding.

As I have already said, the loyalty and unselfish efforts on the part of the Executive Committee members is almost beyond belief. I am thinking of five men who made separate trips to Dayton when I had just come out of the hospital and could not travel. All of them could ill afford to take that much time from their work. One of them was in such poor health at that time that it was a question whether he could travel any better than I, yet he said "Just tell me when it would help for me to come and I'll be there."

Also, I am thinking of a member of the Executive Committee who has a position of unusually great responsibility and whom I asked to serve as a Divisional Chairman. His answer was, "I am totally unfamiliar with what I should do, but if it will help, I will be glad to undertake it." He carried out the work in the wonderfully thorough manner characteristic, paradoxically, of men who have the least amount of time to spare.

Purposely, I have refrained from mentioning any names as, if I started, I would not know where to stop. Moreover, they are there in the lists of the Executive Committees that I have seen function in the years that I have been connected with the National organization.

However, there is one name that I do wish to mention because he has not been on the Executive Committee for several years. That is Gunnar Nicholson who has given so much of his valuable time during the past year in developing a pension plan for the TAPPI employees. Also, I wish to mention the names of those on the committee, Mr. Pringle, Mr. Price, and Mr. Kumler, who helped him with this work.

Two years ago when my term as President commenced I had in mind several things I wished very much to see accomplished while I was in office. One of them was the adoption of a pension plan; but I had no idea then that work on this already had been started. So I have had the satisfaction of seeing this work completed while I was in office but without the less important self satisfaction of feeling that I was responsible for it.

Have any of you ever taken part in deciding upon a pension plan? I had not, and it was an interesting experience to sit on the side lines and observe the amount of work that is necessary. The kinds of plans that can be selected and the variations of each seem endless. The task of selecting one that would best fit the needs of our organization was tremendous and the hours of work on this plan spent by every member of this committee, were greater than you can possibly imagine. They consulted with the personnel and legal departments of their companies and considered plans suggested by them and by various insurance companies. Some of the members even made staff experts from their companies available for help with the technical details.

Finally, at a meeting of the Executive Committee in December, they presented a plan that was approved with slight changes recommended by some of the members.

After the meeting I happened to remark to one of them that I wondered whether the members of TAPPI had any idea of the number of hours that had been spent by the five men who were working on this, and of the careful consideration that had gone into planning it. This member said to me, "I believe that is what you should tell the members of TAPPI when you talk to them in February. I believe that they would want to know something of the efforts and of the sincerity with which their interests are considered in these meetings of ours." It is the result of that suggestion that I am bringing you this message.

However, although the task of this committee was greater than many other projects, I wish to point out that I have no intention to single it out from others that have been carried out in a similar manner. It does furnish a recent example of the kind of work that is being done.

Another development that was started some time ago, but that has increased in importance during the past two years, centers in our Research Appropriations Committee. Ten requests for Research Appropriations were approved in 1951 and eleven more in 1952. All of these have been carefully scrutinized by the members of the Research Appropriations Committee and granted on the basis of the benefit that would be derived by the members of TAPPI. Several were

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refused on the basis of being a duplication of previous work or not being of sufficient general interest.

It seems to me that money spent in this way to implement the work of our committees is one of the most desirable uses of TAPPI funds because the information obtained through research projects benefits all the members of TAPPI; providing the money is spent wisely.

First, we must be sure that we limit such research grants to amounts that TAPPI can afford. It would be easy to make commitments that would embarrass TAPPI financially.

Second, we must be certain that money spent in this way results in information that is of sufficient general interest that the majority of our members would approve the expenditure. This is often a difficult decision.

The Research Appropriations Committee is being very conscientious in both of these respects. If, in their efforts to spend your money to your best interests, the members of the Research Appropriations Committee should refuse some of your requests, I hope that you will understand that it is because they feel deeply the responsibility that has been given them.

I have told you some of the problems of the Executive Committee. There are many others, of course, that have been solved during the past years and many that still face it. Among others, the growth of TAPPI makes it inevitable that sooner or later we will have to have larger offices and a larger staff. However, knowing the men who are your officers and Executive Committee for the coming years, I can assure you that the decisions that lie ahead will be well made and that you can count on the continued progress of TAPPI.

Although, in this little talk, I have tried to tell you something of the work of the Executive Committee, it also has been, in a way, a tribute to its members who have been serving you so faithfully.

However, I wish to pay tribute to others who have been serving you just as faithfully.

During the past year we have lost two men to whom TAPPI owes a great debt.

In March we lost B. W. Scribner who for over 25 years was Chairman of our Paper Testing Committee and was responsible for many of our testing methods. To him we owe our appreciation of his years of untiring service and devotion to the interests of TAPPI.

Now within the last few weeks we have lost Dr. C. J. West, author of all of our bibliographies and Chairman of the Editorial Board of *Tappi*. You all know of Dr. West's international reputation, and how fortunate we have been to have such a man give so freely of his time and energy. I believe all of you know what his loss means to TAPPI.

I wish to pay tribute to both of these men, not only because of what they have done for us and because in them TAPPI has lost two good friends, but also as personal friends whom I will miss more than I can tell you.

As long as TAPPI has men like them and such as those who will be directing its destinies in the foreseeable future, I know that all of us can rest assured that its future is safe.

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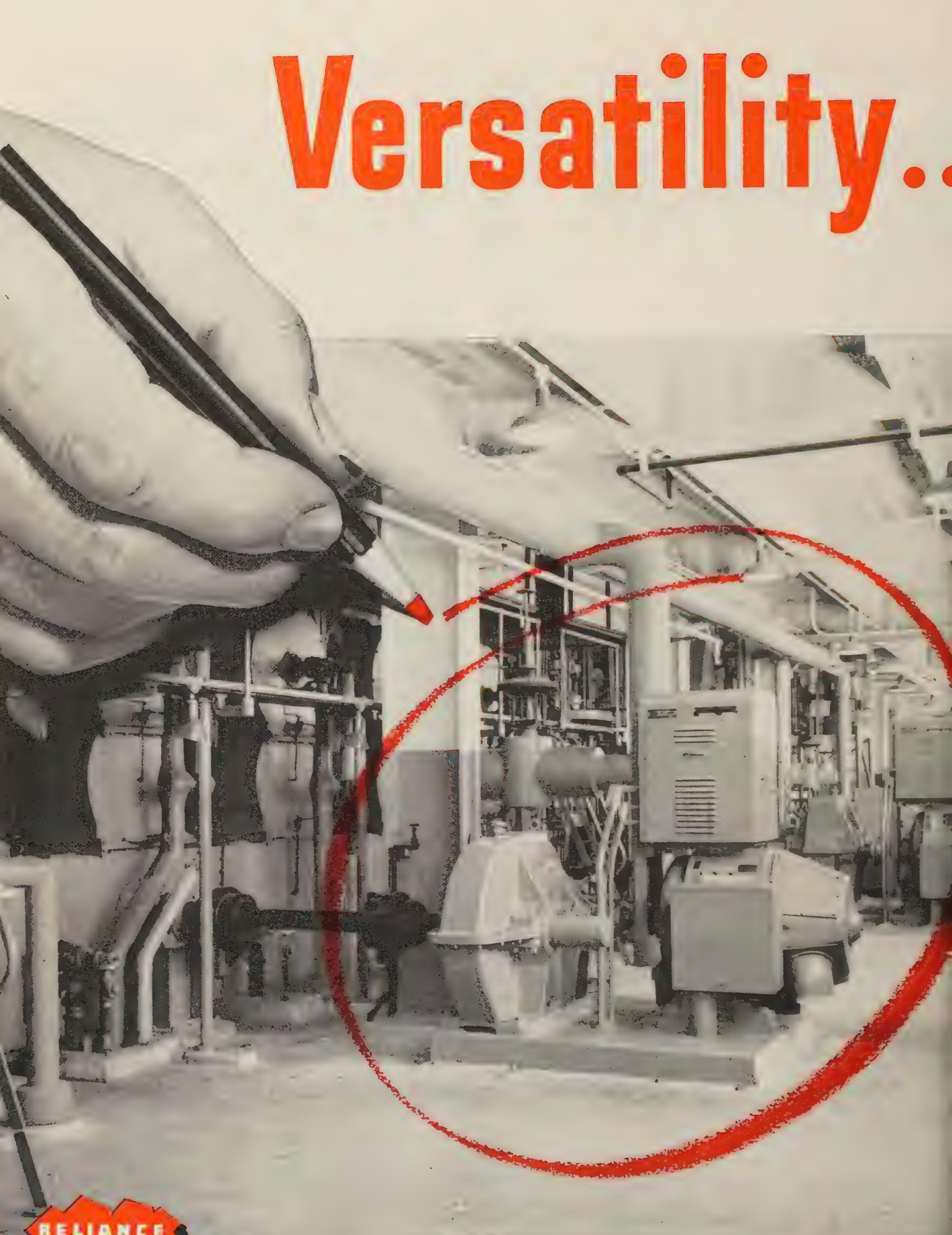

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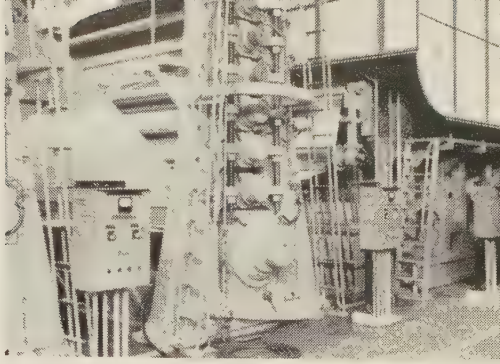
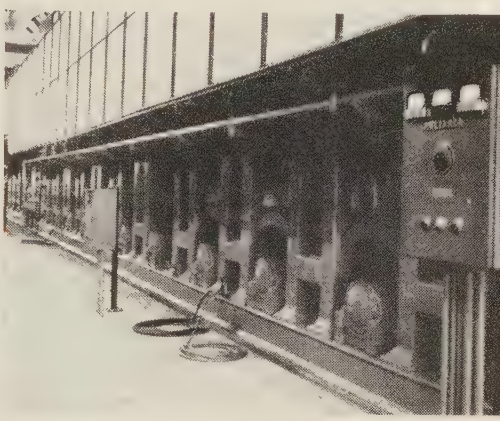
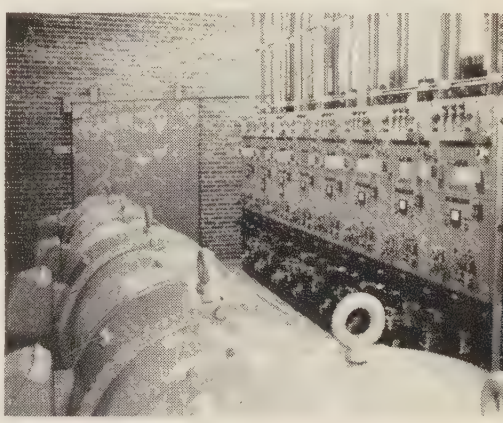


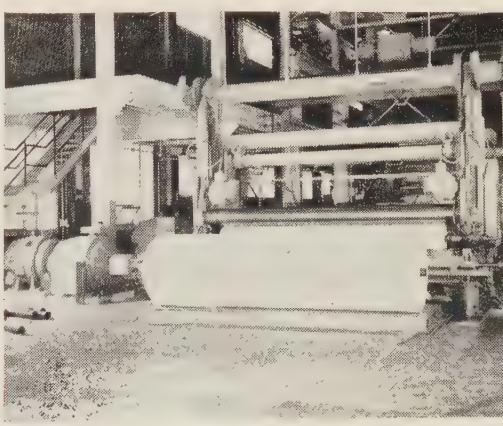
On the three eight-roll calender stacks, the Reliance cont provides a new and very effective method of taking up sl without disturbing the draw setting through this secti Typical operators' control stations appear in foreground.



Master control station. Micrometer dial turns through revolutions, each calibrated into 100 divisions, permitti accurate presetting of speeds within less than ½ fpm.



Reliance Multiple Generator Set is conveniently located separate room beneath the drive area. Each generator ser one machine section. Electronic and magnetic contr grouped in panels at right afford flexibility of individu section operation and adjustment.



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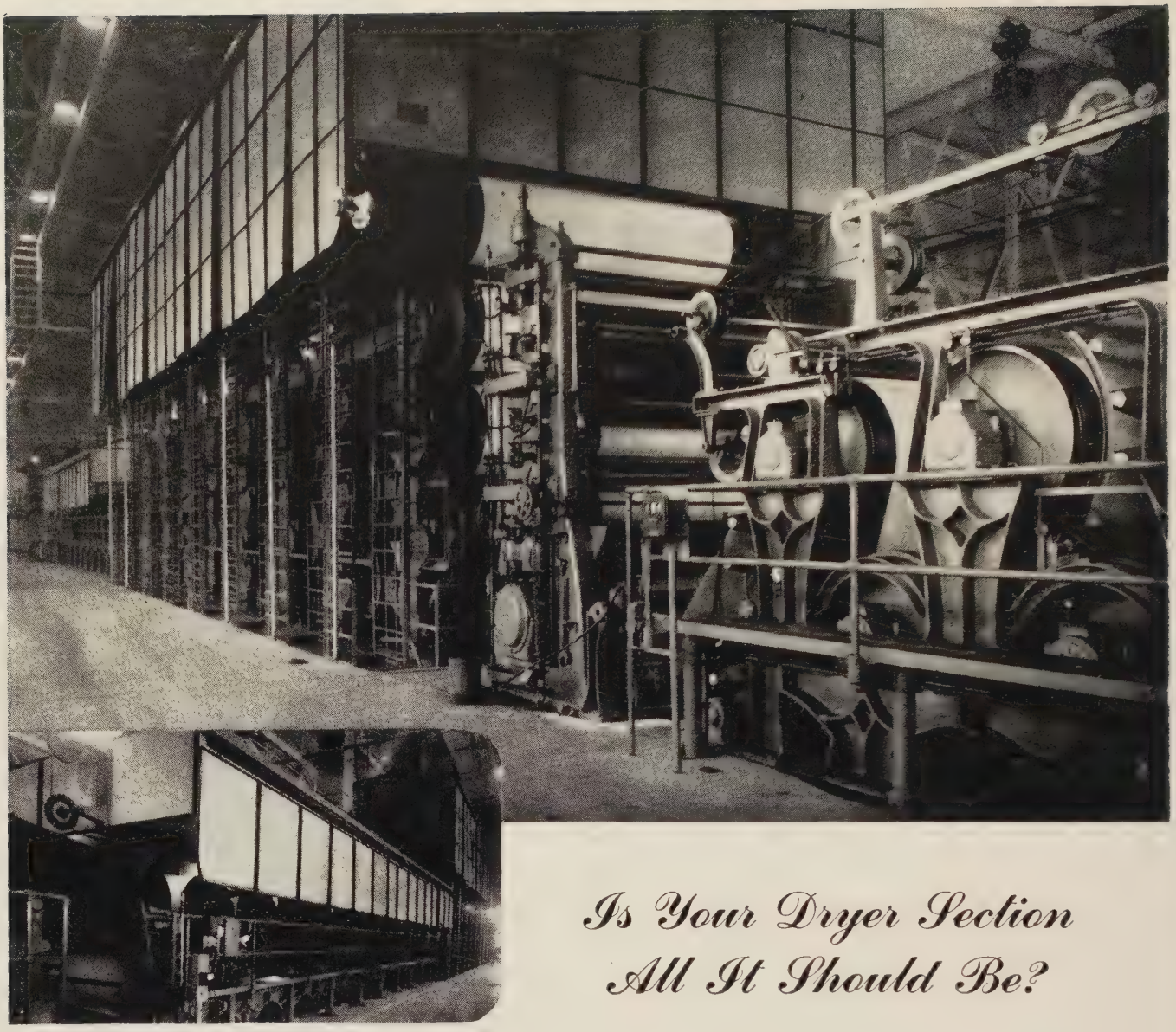

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THE PROGRESS OF RESEARCH IN THE PULP AND PAPER INDUSTRY

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Allen Abrams

THE history of research is a tale of curious people —restless men seeking always for something different. There were Adam and Eve, testing a new fruit and ending up with leaves for clothing; the aborigine discovering fire; the alchemist pursuing the Philosopher's Stone. These were the pioneers—solitary, secretive, untutored, yet laying the groundwork for our modern research.

To the Chaldeans, at the time of the Late Stone Age, goes credit for the first experiment in recording communication. They used palm leaves, stones, shells, and tablets of clay. Crude as they were, these materials and symbols were the beginning of our modern letters, newspapers, and magazines. Nearly 30 centuries later, at the time some of our giant California sequoias were just sprouting, a curious native in Egypt sliced a papyrus stalk, laminated a number of these strips together and made the first synthetic sheet for receiving symbols and drawings. But the King of Pergamum, an inventor in his own right and not to be outdone, scraped clean the inner part of sheep skin and made another material, parchment. For many centuries this skin was employed to produce books and manuscripts, especially in the monasteries where many beautiful examples are still to be seen. Throughout history religious people have played an important part in the development of the paper industry.

In the 6000 years before the birth of Christ materials for transmitting thought were cumbersome and the methods crude. Then in the year 105 A.D. a Chinese, T'sai Lun, made a truly great invention. He shredded bamboo, rags, and other materials in water, dipped a cloth-covered frame into the suspension, permitted the water to drain off, and thus produced a sheet of paper. From that day on, these principles have been used in our industry, even in the design of high-speed paper machines. In China, T'sai Lun's new material found rapid acceptance, and the Chinese went to work developing characters for writing and printing, possibly looking to the day when they would be making laundry checks in America. Seven centuries elapsed before a printed manuscript was produced in China, but it was a dandy for the scroll was 16 ft. in length. Thus, a thousand years ago we had the Chinese version of "Gone With the Wind."

Meanwhile the enterprising Egyptians had been busy on a new use of paper, and one which was eventually to become our most important market—the transportation of things. In Cairo, during the eleventh century, some ingenious person had provided the merchants with paper in which they wrapped hardware, vegetables, and spices. This use created such a demand for paper and such a shortage in rags that the Bedouins searched old cities to recover cloth bands from the dead. Nearly 800 years later a similar shortage of rags developed in the United States, resulting in the importation of mummies so that the shrouds could be used to make food papers. Certainly research in sanitation had progressed slowly.

Up to the fifteenth century, the art of printing as practiced in China and Japan had developed little because of poor equipment and the multitude of characters. Early in that century Johann Gutenberg in Germany was making a compact with his partners for working out secret processes of printing. In fact, these were so secret and the results so startling that the authorities suspected Gutenberg of practicing magic—a rather natural supposition as the alchemist was still strongly in evidence. Gutenberg's 42-line Bible, printed with movable metal type on paper never since excelled, started European publications on a grand scale. His research in printing yielded inventions of incalculable value, resulting in a rapid spread of literature throughout Europe, and eventually bringing an enormous demand for paper. Thus progress in one field stimulates the use of products from another field.

The increased need for paper set inventors to developing improved equipment and to installing paper mills. Within the century there were mills in England and in many European countries. Incredible as it may seem and much as they would dispute it today, the Russians built no mill until many years later. In the United States the first paper mill was built by William Rittenhouse in 1690, near Philadelphia. Such an event called for a eulogy by Richard Frame:

> "The German-Town of which I spoke before
> Which is, at least, in length one mile and more
> Where lives high-German people, and low-Dutch
> Whose trade in weaving linen cloth is much
> From linen rags good paper doth derive
> The first trade keeps the second trade alive."

Throughout the world paper mills were drawing so

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heavily on their principal raw material that an acute shortage of rags was developing. The British hesitated to bring rags into their country because of a plague brought about by these importations, and they had issued an order prohibiting the use of linen or cotton burial shrouds. In the United States the heavy drain called for numerous advertisements such as the one in the Virginia Almanack of 1749: "The printer hereof having a paper mill now at work near this city, desires all persons to save their old linen rags for making paper. . . . Old thread stockings which can be used no other way will make good paper."

By the time of the Revolutionary War rags were so scarce that the price had risen to nearly $2.00 per lb. In 1786, to save material, the Philadelphia Society of Sciences was offering a prize for the best way of protecting paper from insects. The American Company of Booksellers had struck a gold medal to be awarded the person who would prepare good paper from material other than cloth. It had now become crystal clear that the paper industry faced a limited future unless a more abundant raw material could be found. Necessity, the mother of invention, was looking to research for the fathering of her child.

Into this picture, during the latter part of the eighteenth century, came Dr. Jacob Christian Schaffer, a German clergyman, whose principal activity seemed to be outside the church. Schaffer experimented with more than 80 vegetable fibers, not so much to make good paper as to indicate the vast variety of vegetation available for the purpose. Reaumur, the French naturalist, had already observed how the wasp made fine paper for its nest from wood fibers. Schaffer used these nests to produce sheets, then went on to other materials such as hemp, bark, straw, corn husks, and even a few species of wood. Perhaps it was Schaffer's monumental six-volume work which set Matthias Koops to experimenting in England. Little is known of his history, yet to Koops goes credit for the first use of vegetable fibers on a commercial scale. A major

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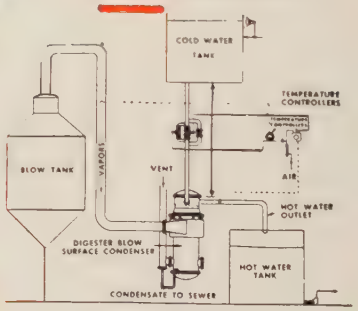

Flow diagram shows general arrangement of Blow Condenser System

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part of our present industry is based on the work of Koops, a great researcher and a man of vision. In 1800 he published a remarkable volume on paper made solely from straw and wood, commenting in the book that "the art of papermaking ought to be regarded as one of the most useful which has ever been invented in any age or country; for it is manifest that every other discovery must have continued useless to society if it could not have been disseminated by manuscripts or by printing."

By his very nature the research man is ahead of his times, so that Koops had an indifferent reception from the English papermakers. Together with several other men he built a large mill which went promptly into bankruptcy, leaving many disgruntled stockholders and distressed employees. The way was now open for Freidrich Gottlob Keller in Germany to benefit from the studies of Reaumur and Koops. Observing that the wasp scraped fibers from wood, Keller used this principle in the development of a wood grinding machine. In later years this first process of making wood pulp was to give the world cheap paper, especially for newsprint.

Almost simultaneously with Keller two Englishmen, Burgess and Watt, were experimenting with the digestion of wood by various chemicals. From this research came our modern soda process, so little appreciated by the British that the newspapers derided the inventors, causing them to come to the United States. Here they established a plant at Manayunk, Pa. the first to make chemical pulp on a large scale. Our improved patent system had then been in effect for several years, enabling Burgess and Watt to secure coverage in 1854. The incentive and protection offered by this system were to be revealed constantly in the years ahead as more inventors concentrated their talents on paper making needs.

In Paris, Benjamin Tilghman had set up a laboratory to investigate the action of sulphurous acid on fats—a study quite unrelated to pulpmaking. The acid solution was kept in a barrel and Tilghman's observant eye noted that the wood of the barrel was becoming soft and fuzzy. A few years later on visiting the soda pulp plant at Manayunk, Tilghman recalled his experiments in Paris. This set him to studying the effect of sulphurous acid on wood at high temperature and pressure. The principle of the sulphite process, involving the use of a lime base, was then tried out in a large digester. After battling for months against leaks caused by faulty linings, Tilghman and his brother gave up in discouragement, having lost their shirts and two years of hard work. At this point Carl Ekman, a Swede, took over the process, which he perfected and put into commercial operation. Within a few years another Swede, Carl Dahl, had invented the sulphate process, the last of our three principal chemical methods of making pulp from wood.

For over 1700 years the world had been dependent almost entirely on rags as the raw material for paper. Now, in less than a century, research workers in England, France, Germany, Sweden, and the United States had opened up a vast new source of raw material and had developed the presently used processes of pulpmaking. In that same period there had been invented the two principal paper machines, the fourdrinier and the cylinder, both based on the work of T'sai Lun.

At the beginning of the twentieth century the pulp and paper industry was in a strategic position, well supplied with the raw materials and the equipment required for unlimited development. Now the urgent need was to expand the use of present products and to create new products. Even though it was little recognized at that time, research was presenting a golden opportunity to the scientist and engineer of curious mind. But would they be able to conquer the skepticism and the inertia of the times? In 1900 there were relatively few engineers and scientists in the United States, and most of these were suspected of having halitosis. In 1910, at the time the Forest Products Laboratory was established to study wood, only a handful of paper mill chemists could be found.

Then, on Feb. 19, 1915, 38 years ago to the day, a significant meeting took place. Twenty-seven men gathered in New York and after due deliberation decided to organize the Technical Association of the Pulp and Paper Industry. Among its objectives were to be the promotion of research and the interchange of ideas among its members. As subjects of immediate investigation TAPPI set out to establish a method for testing pulp; to formulate standard definitions for grades of paper; to suggest a new unit for buying pulpwood; to find uses for by-products. Certainly no one could accuse the founders of TAPPI of having grandiose plans, nor could anyone venture that on its thirty-eighth anniversary this great organization would include more than 5000 scientists, engineers, managers, and production men.

Arthur D. Little, official chemist of the American Pulp and Paper Association, had been telling business men that "the price of progress is research, which alone assures the security of dividends" warning that industry faced failure unless it made use of the technical man. A few pulp and paper companies had responded but business men generally were unimpressed. Then came World War I, and some of my associates here will recall that the use of poison gas called us suddenly into service, gave the scientist a lift, and brought research to the foreground.

In 1920 a forward looking paper manufacturer, D. C. Everest, was saying "it is safe to say that only those organizations in which the program of research was definite have succeeded in placing the manufacture of their product on a sound basis." Nearly a quarter of a century later TAPPI was to recognize his vision by rewarding him with its gold medal. Research laboratories were being installed, TAPPI membership was rising, the engineer and scientist were now permitted in the mill unscathed. The industry was developing new products, expanding rapidly, and acquiring more problems. The technical man was being used in research, in manufacture, and in sales. Ernst Mahler and his associates had founded The Institute of Paper Chemistry in 1929 to train college graduates for responsible positions in the paper industry.

Then overnight the depression hit and industry began to tighten its belt, too often by dispensing with the research staff. An editorial in *Industrial and Engineering Chemistry* reminded "our captains of finance that research and the chemist have become permanent necessities for a successful industry." Shortly we were

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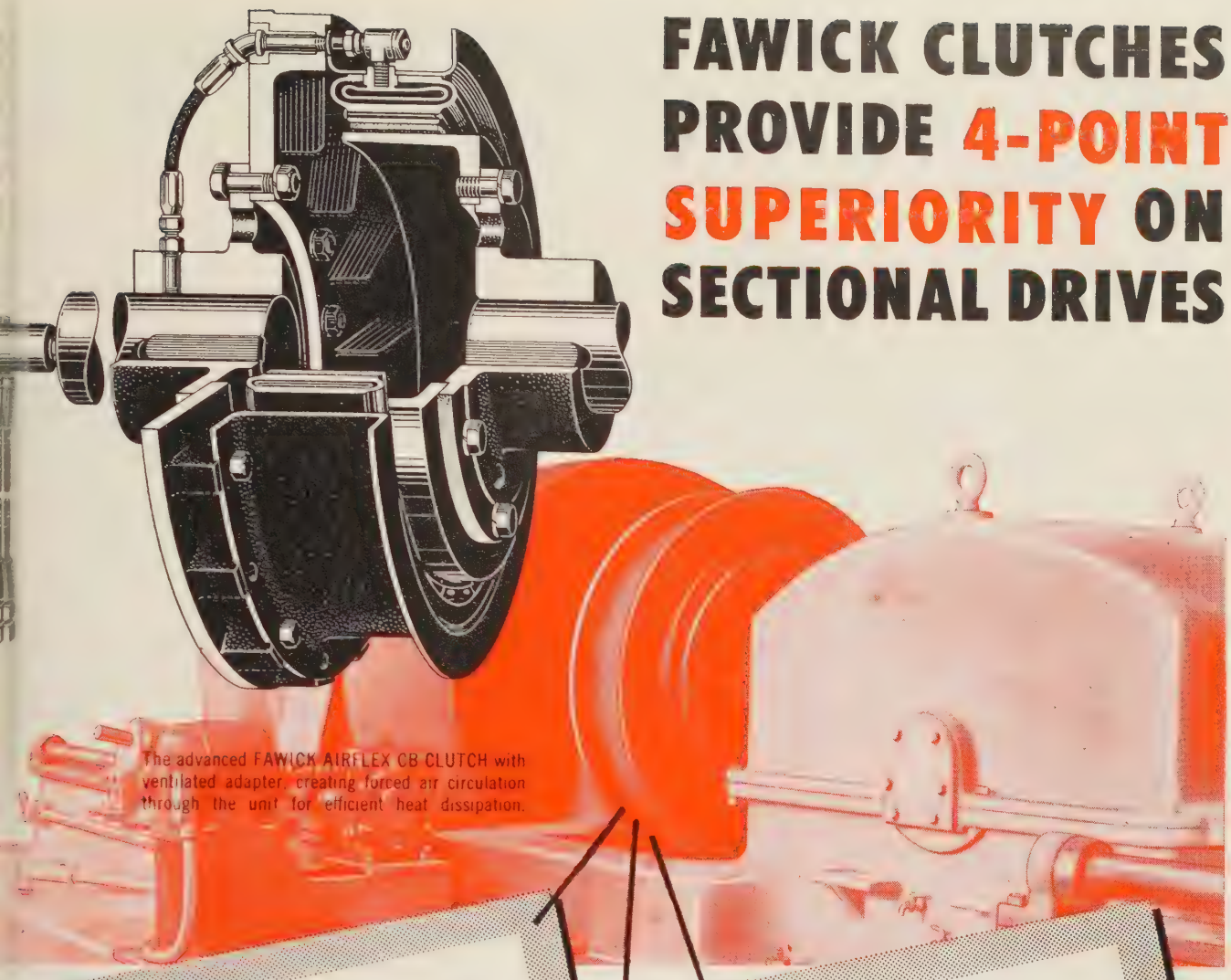

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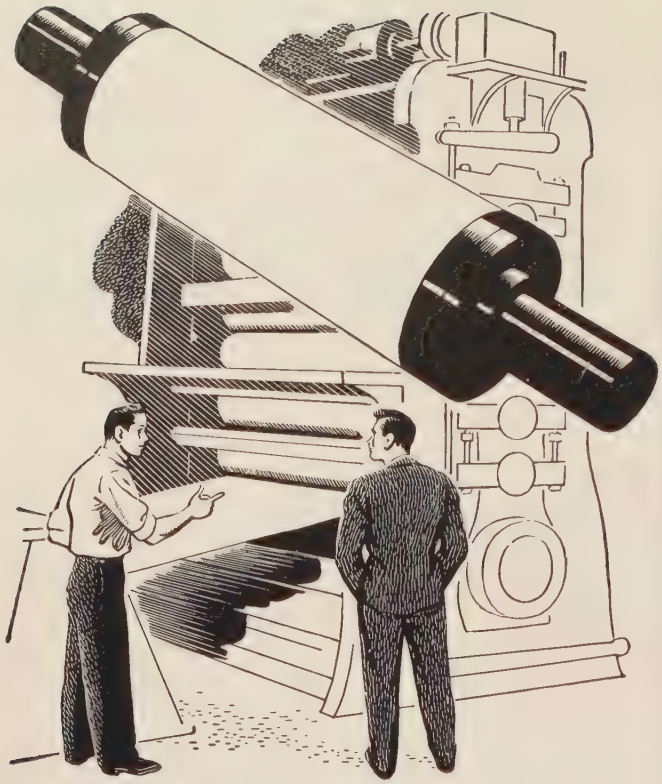

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in another war economy, and to this day the demand for research scientists and engineers has never been met.

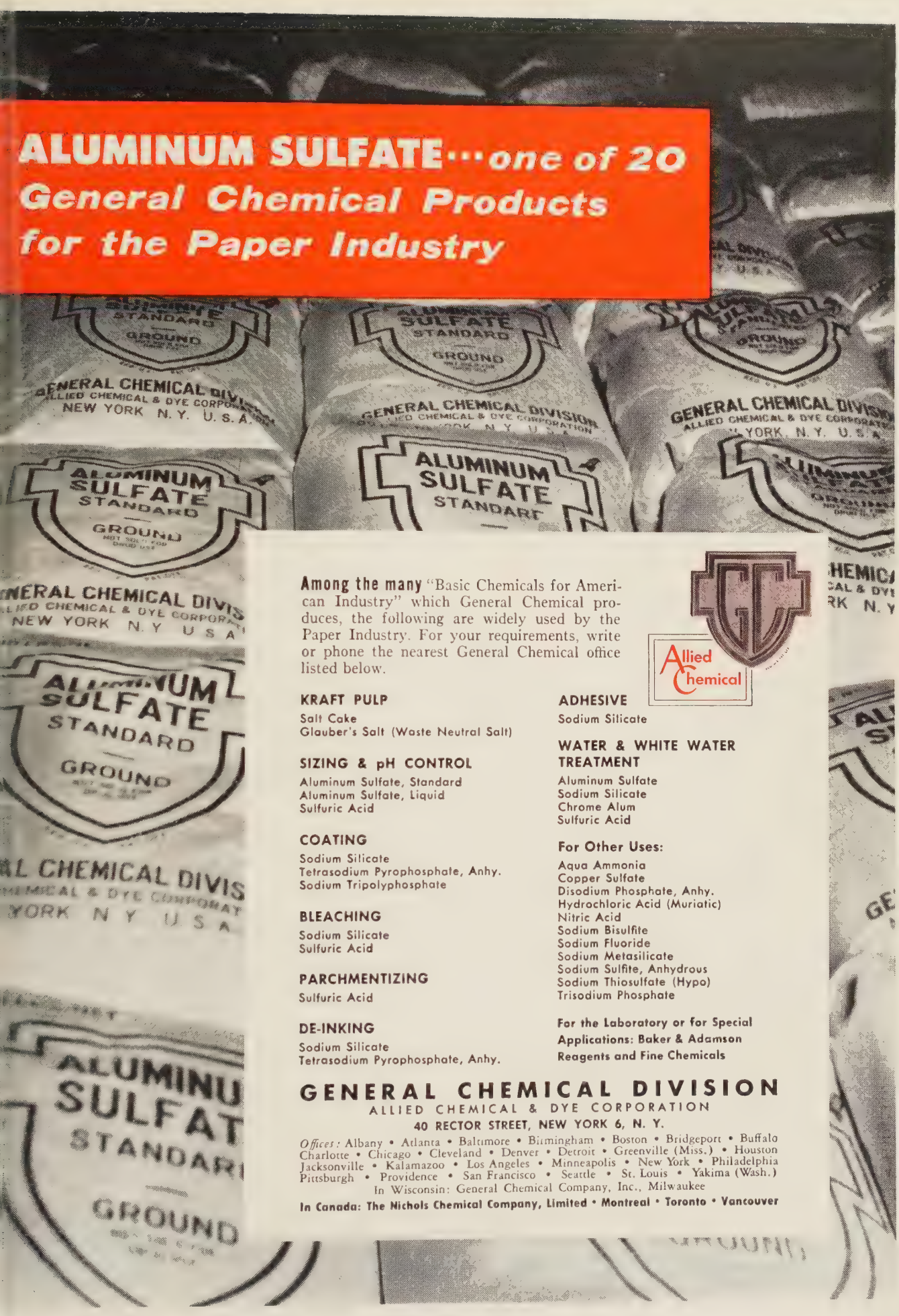
Seldom can contemporaries assess adequately the age in which they live. Even so we shall recall changes brought about by research in our own industry, particularly during the past half century. In these years we have become better acquainted with our prime raw material, wood—recognizing it as an inexhaustible resource if properly harvested and renewed. We are learning how to plant trees properly, to double our cellulose yield with new species, to employ former weed trees, to use our waste wood and lignin. Through the fundamental researches of Cross, Bevan, Hagglund, Heuser, Klason, and Schwalbe on cellulose and lignin we know how to make stronger, whiter pulps; with cellulose we have built new industries such as cellophane, rayon, and nitrocellulose; we have developed chemical products of lignin for drilling oil wells, tanning leather, conditioning boiler water, making yeast, and flavoring ice cream. To improve the operations of our industry we have designed new equipment and accelerated our paper machines to 30 m.p.h. By the use of machinery, electronic equipment, and other gadgets we have lightened labor, reduced human error, and made products cheaper and better.

Statistically in 50 years, the population of the United States has doubled but scientists and engineers have increased ten times. The per capita consumption of paper has risen six times and the total use twelve times. By transmission of thought and information through newspapers, magazines, books, and by correspondence we have become the best informed people in the world. Through the transportation of things in containers, bags, boxes, and other wrappings, industries have been created, diversified, and accelerated enormously.

Gone are the unsanitary times of the open cracker barrel, the naked toothbrush, the common drinking cup and towel. Present are the days when industry demands a whole gamut of papers, and the housewife revels in an array of disposable paper articles. Today no city or industry could be planned or built, no merchant could carry on, no business could run, no government could operate, should our paper mills close down. Only sixth in size of the nation's industries, we are near the top of the list in importance.

All this has been brought about by the combined efforts of the man who dreams and the man who executes. For the research of today is different from the alchemy of yesterday in its organization and operation as a business and in its integration with other segments of our industrial life. Now we have the acceleration brought about through cooperation and the interchange of ideas—by organizations such as TAPPI, in schools such as The Institute of Paper Chemistry, through modest men working in little appreciated fields—Clarence West who spent his lifetime compiling and publishing vital information, Dard Hunter circling the globe to collect and publish by his own hand the history of our great industry, Roger Griffin in his development of standards.

In his very nature the true research man is a modest individual, generally unvocal and seldom pictured as a Man of Distinction or nominated for Man of the Year. Deficient in selling his own wares, he needs the understanding, and he solicits the help, of others. Like a



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Sulfuric Acid

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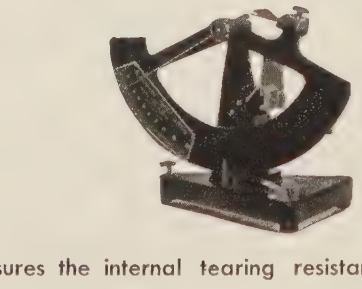
ELMENDORF TEARING TESTER



Measures the internal tearing resistance of paper, textiles and sheet materials in gram-centimeters. Dependent upon gravity for its operation; the readings must be correct. Any two Elmendorfs anywhere will perform alike under like conditions. Tearing resistance is the most practical test for predicting wearing quality. It is a measure of service. TAPPI, ASTM and Federal Standard. Made in many capacities.

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physician the researcher can only diagnose the trouble and suggest the remedy. Nor can the researcher, any more than the physician, predict in advance of a blessed event the time of arrival and whether the baby will be stillborn, or as to what may be the color, traits, and even future value of the child. Yet some hard-headed industrialists would demand of the researcher what they would never ask of their doctor.

Research in the pulp and paper industry has not advanced as rapidly as we should like to have it. In a recent study we found that only 50 companies, out of more than 500 in the industry, have research staffs with ten or more scientists. All of these companies have highest financial rating and 80% of them are listed on the New York Stock Exchange. Their research organizations employ about 1000 scientists, together with auxiliary personnel, spending a total of approximately 20 million dollars per year. Since these companies produce about one half the tonnage of the industry we estimate their sales at 3 billion dollars. We then conclude that they are spending on research not more than 0.7 cent out of each sales dollar. The remaining companies are investing less than this in research, so that our industry is on the low side in comparison with others. In fact, many companies will allot more to such functions as advertising and property insurance than to this form of protection for the future.

One reason for the low expenditures on research lies in the difficulty of measuring its accomplishments. The manufacturing department comes up with an impressive exhibit of units produced and the sales department points with pride to the dollars it has taken in. The research man has no such simple gage, and many directors of research would have fewer ulcers if they did have an adequate check on their activities. Some companies have procedures for crediting research with a part of the benefits from new and improved products and processes developed through research. Employing these credits, such companies cite returns of as much as five to ten times the entire cost of operating the department.

Most research men would prefer to have their contributions judged by the general health and progress of their companies and their industry. They urge that we have more fundamental fact finding, without relation to any specific objectives, because out of these apparently purposeless investigations have come some of our greatest discoveries. They view with gratitude the contributions of men such as T'sai Lun, Gutenberg, Koops, Fourdrinier, Keller, and Cross. For throughout our whole history we have seen in these men the working of the research mind on a grand scale—curious, acquisitive, relating one observation to another and eventually bringing vast benefits to humanity. In the utter disregard of the research mind for racial or geographical boundaries, we have had examples of cooperation and synergism of the highest order, idea stimulating idea, developments of one field benefiting another.

Throughout our long history we have observed the inertia and the cruelty of the mass mind, resisting change, heaping derision and discouragement on the man who would pioneer. Yet finally we have found vindication of our own opportunity system, demonstrating to explorers the risks they must run but offering reward and protection to those who will persevere. With Mathias Koops we can say "History furnishes us with numerous examples of one discovery giving birth to others, and if my success . . . should incite active and industrious artists to make further improvements in their various manufactures, my feelings will be amply gratified."

Now, to the young men of our industry, a parting word. More than ever before we need fact finders and the application of science and engineering to our business, that we may outdistance competition from other industries. You young men should become better acquainted with the tree, the very foundation of our industry. Study its habits—how to develop hardier strains, how to produce cellulose faster, how to waste less through fire, pest, disease, and in our logging practices. Look with a critical eye at the methods and equipment for manufacturing pulp and paper, since many of these are overdue for change. Keeping in mind that paper is still the cheapest and most versatile sheet material, concentrate your energies on improving present products and on finding new products and markets. Above all, since you are the hope of our industry, learn how to express yourselves clearly, that you may be able to sell your findings to the man who can put them to use.

The great developments of the future will come through the man who is curious, observant, persistent. The climate of these United States is a favorable one for the man who has the will to succeed. Let no one tell you that the day of opportunity is closing. For you the sun has just begun to rise.

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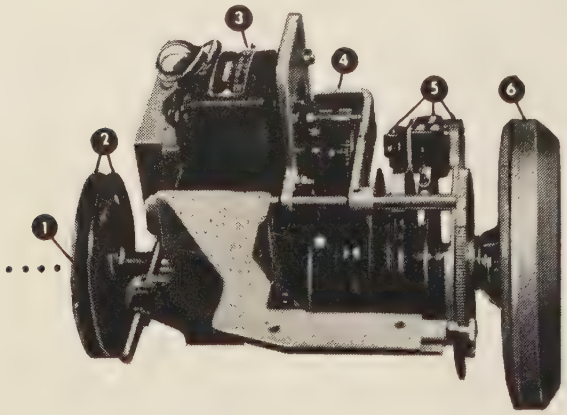
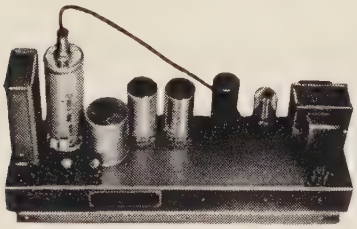


POWER IS PERFORMANCE

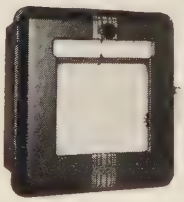
... and Speedomax Instruments lead with "huge" 12-watt balancing motors!

This partially dis-assembled view of Speedomax shows its two-phase Balancing Motor and gears, with a typically "heavy" load of slidewires and contacting cams for signal and control devices. Several more cams, etc., can be added if necessary; only practical limit is physical space on shaft. Smoothness in operating many contacts is an outstanding Speedomax ability.



Amplifier which feeds the Speedomax balancing motor the controlling half of its power. Torque gradient is especially high where needed most—around balance point—for prompt, positive balancing. This Amplifier leads its field by large margins in sensitivity and in power output.

Good circuit engineering shows in this Slidewire's non-inductive wiring and in the absence of any flexible leads which might form inductive loops.



• Power underlies good performance, in instruments as in automobiles, machine tools or rolling mills. That's why L&N engineers insist that an automatic instrument should operate as positively and promptly as any other high-grade machine.

Even the first null balance potentiometer Recorder we built, back in 1911, which went to a steel mill, had a 110-volt motor instead of a spring drive to run its balancing mechanism, chart and signalling contacts. And, while its pioneering of balance-method measurement attracted the most attention, its ample power certainly helped establish L&N Recorders as the coming idea in process Instrumentation.

Power has done the same for Speedomax instruments. Twenty years ago, Speedomax pioneered the electronic idea of measurement—in a husky, powerful piece of equipment. Today's models have from 2 to 4 times more power in their balancing motors than any other current models of electronic controllers, recorders or indicators.

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Speedomax for industrial use is described in Catalog ND46 (1); additional information for unusual applications is given in Technical Publication ND46(1). Either will be sent on request by our nearest office or from 4909 Stenton Ave., Philadelphia 44, Pa.

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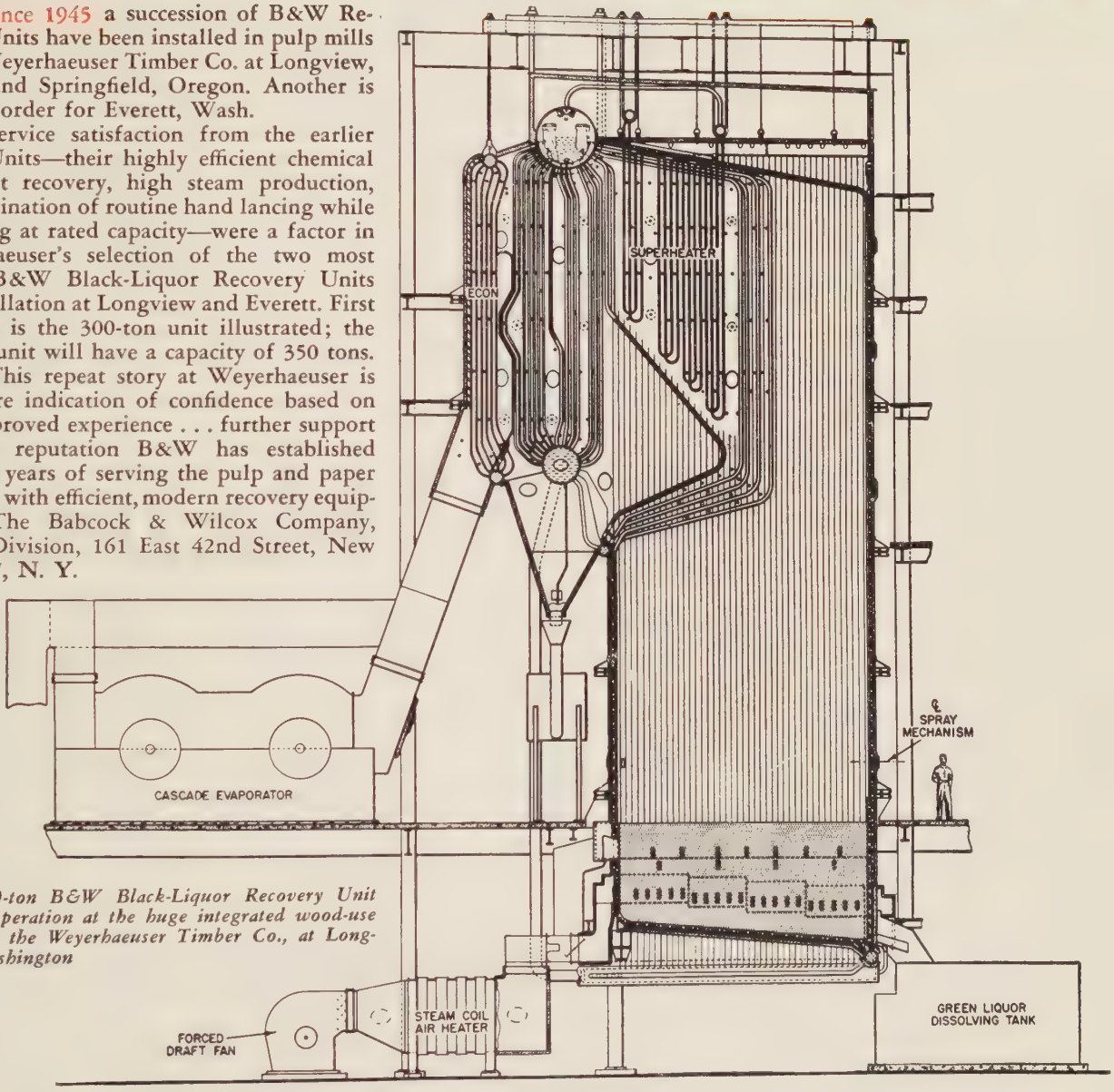
This repeat story at Weyerhaeuser is one more indication of confidence based on service-proved experience . . . further support for the reputation B&W has established through years of serving the pulp and paper industry with efficient, modern recovery equipment. The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, N. Y.



New 300-ton B&W Black-Liquor Recovery Unit now in operation at the huge integrated wood-use center of the Weyerhaeuser Timber Co., at Longview, Washington

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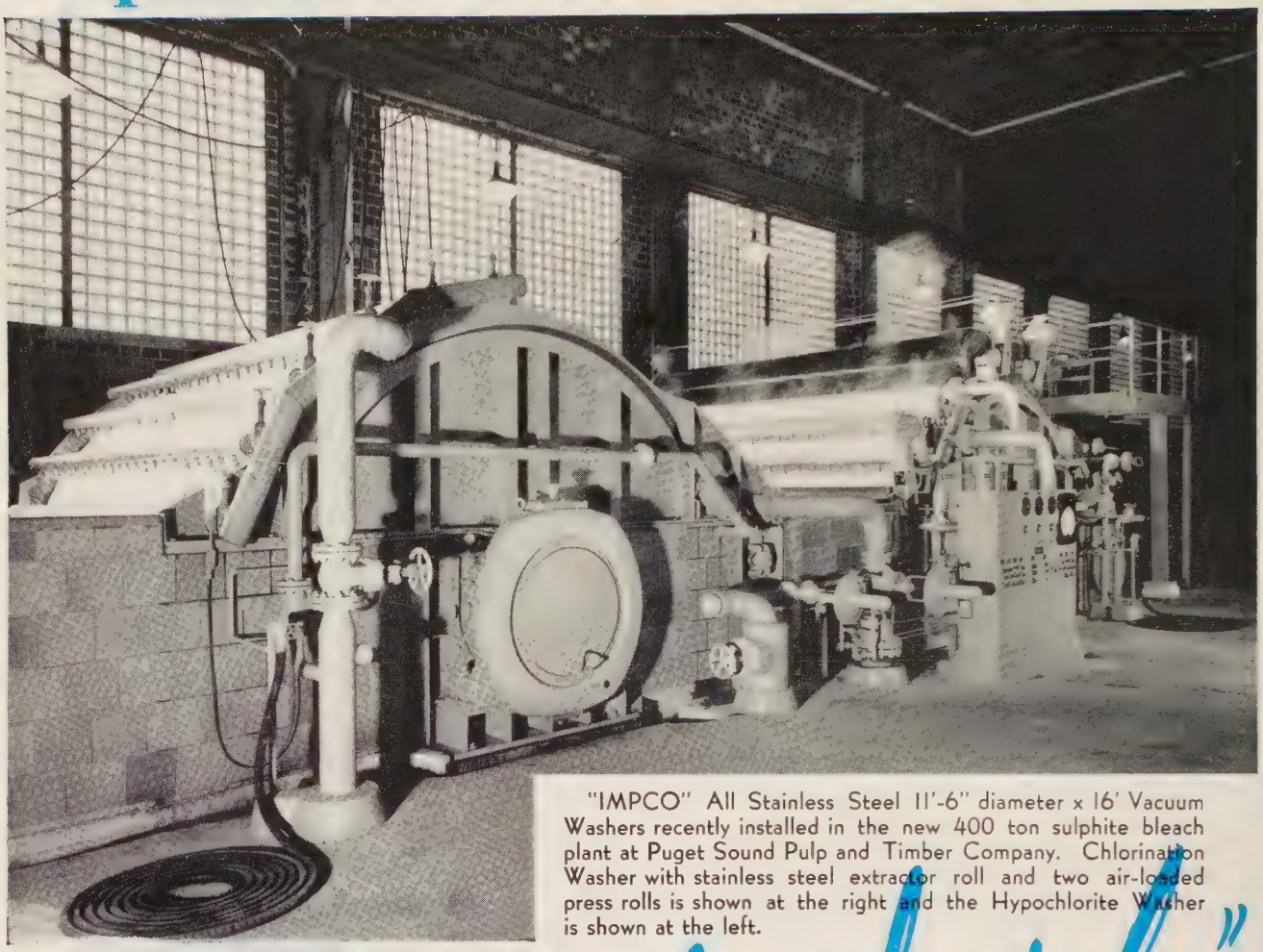

"IMPCO" All Stainless Steel 11'-6" diameter x 16' Vacuum Washers recently installed in the new 400 ton sulphite bleach plant at Puget Sound Pulp and Timber Company. Chlorination Washer with stainless steel extractor roll and two air-loaded press rolls is shown at the right and the Hypochlorite Washer is shown at the left.

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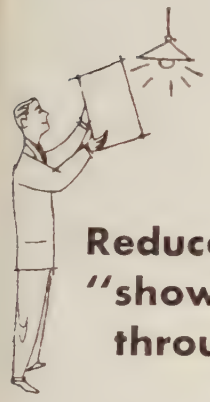

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Because of its unique properties, Celite not only improves the finished sheet but it aids suspension and formation, too. A Celite field engineer will gladly show you how Celite can help you produce better paper at lower cost. For his services, simply write Johns-Manville, Box 60, New York 16, N. Y. In Canada, 199 Bay St., Toronto 1, Ontario. No obligation, of course.

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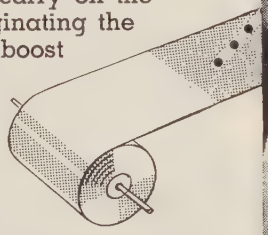

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Weyerhaeuser, Pulp Div., Longview, Wash.
Weyerhaeuser, Pulp Div., Springfield, Ore.
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Long Lac Pulp & Paper Co., Ltd., Terrace Bay, Ont.
Columbia Cellulose Co., Ltd., Watson Island, B. C.
Sorg Pulp Co., Ltd., Port Mellon, B. C.
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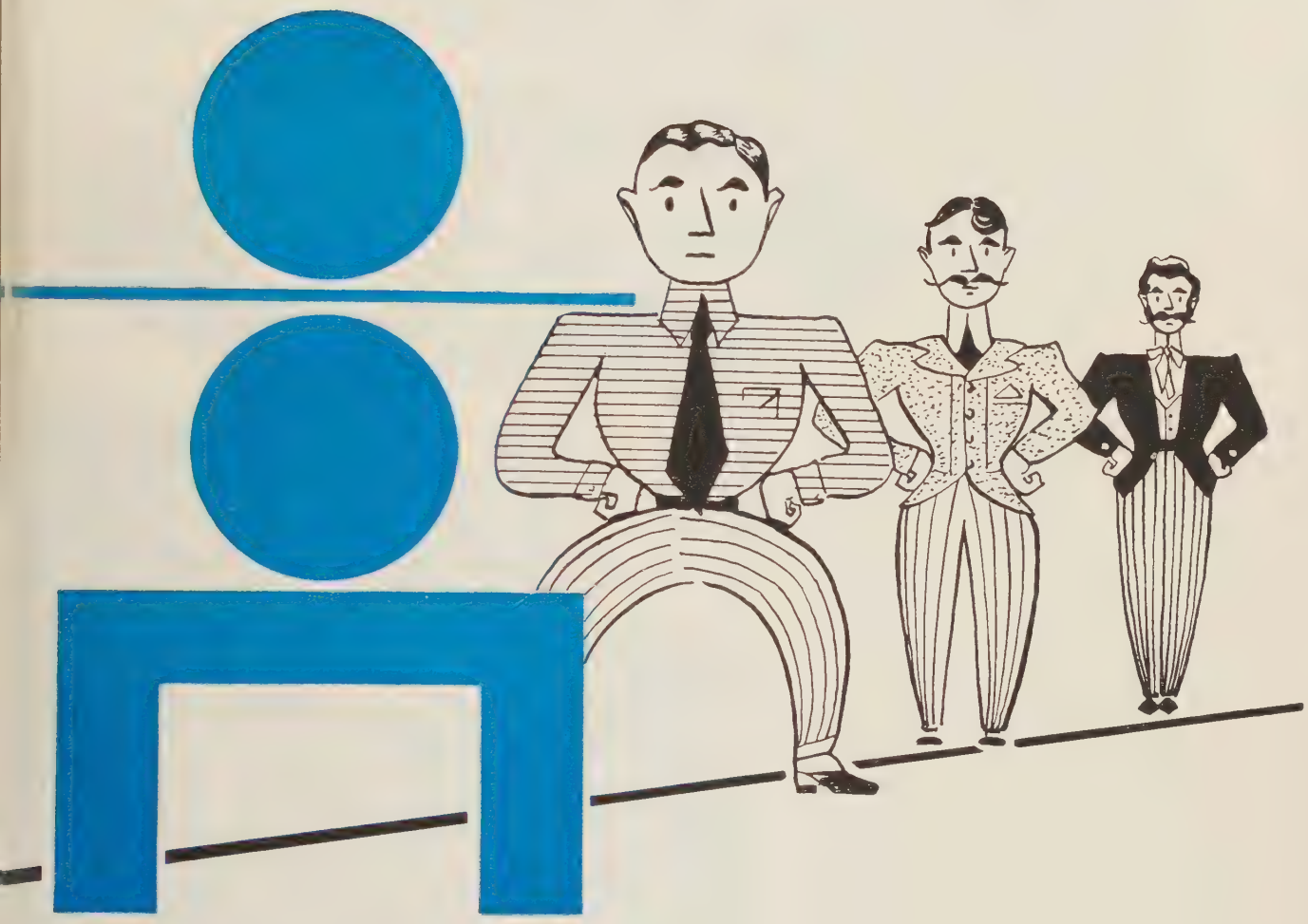

INTEGRITY is as much a part of a Rice Barton paper machine NOW as it was in 1837

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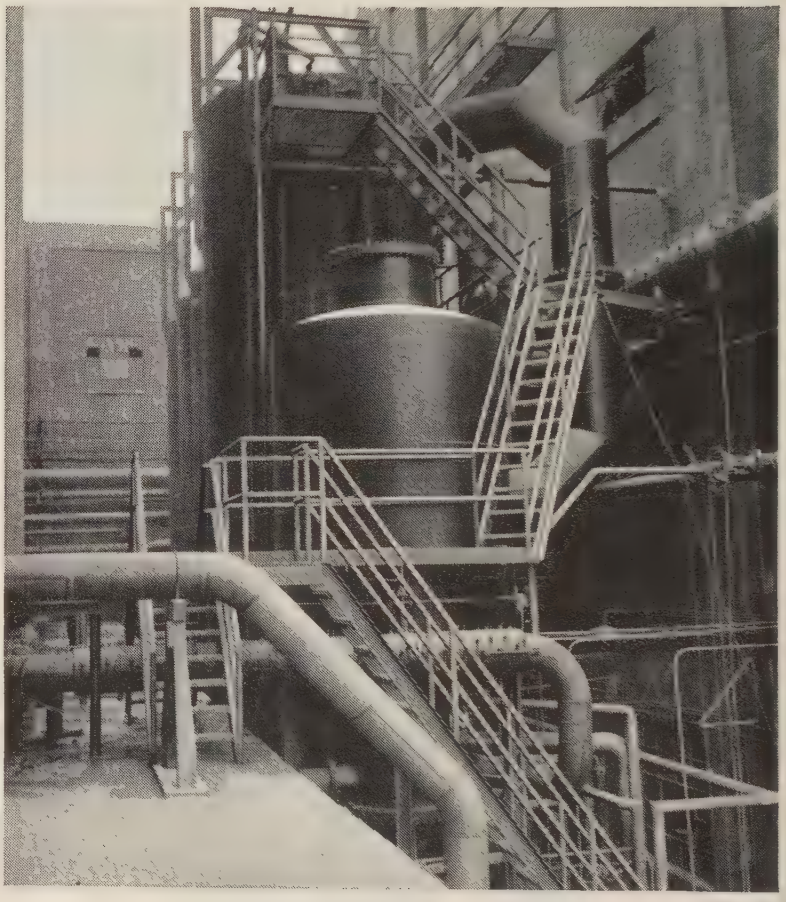

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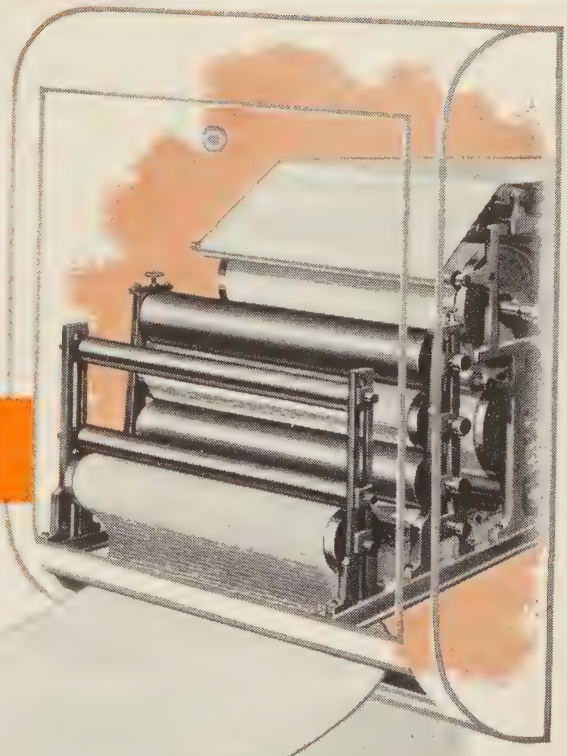

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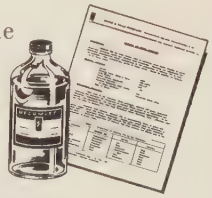

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REPORTS AND DISCUSSIONS

Presented at the National and Regional Conferences

Condensations of Annual Meeting Papers

THE following are condensations of a number of papers presented at the 38th Annual Meeting of the Technical Association (Feb. 16–19, 1953). The papers will be published in full in subsequent issues of *Tappi*.

Building a Library Collection for the Pulp and Paper Curriculum at Western Michigan College of Education, TAISTO J. NIEMI

The pulp and paper curriculum at Western Michigan College was in need of research materials in its library. The work in building up this collection has evolved around several phases of cooperation.

This united effort has come about by the following methods: first, there was that of cooperation of different colleges; second, the cooperation of industry and men interested in pulp and paper technology; and third, the cooperation of various noneducational institutions.

The building up of the library collection has followed certain patterns, namely, the addition of current periodicals and book needs first, then the filling in of back volumes of periodicals, and finally, the stressing of nonbook facilities and services. The latter has been carried out mainly through purchase by library funds.

A School of Pulp and Paper Technology for the South, C. E. LIBBY

Notwithstanding the rapid expansion of the paper industry in the south regional educational facilities for the training of young men for this industry at the undergraduate college level have not been established. The School of Forestry at North Carolina State College of Agriculture and Engineering in cooperation with a number of large southern mills will organize a 4-yr. undergraduate curriculum in pulp and paper manufacture and proceed with the building and equipping of a pilot plant laboratory as soon as funds become available from public or private sources.

The potentialities of North Carolina State College as the sponsor of a school of papermaking are unexcelled in the south. Its school of engineering bears a national reputation for excellence and presently has a student enrollment of approximately 2000 men. The school of forestry is the largest and strongest forestry institution south of the Mason-Dixon line. North Carolina State College is just completing a $15,000,000 expansion program that includes an ultra-modern building for its Department of Chemical Engineering and a similar modern structure for the school of forestry—Kilgore Hall—which was officially occupied in January of the present year. The new curriculum in pulp and paper manufacture will exhibit a greater integration of instruction in forestry, chemical engineering, human relations, and specialized courses in pulp and papermaking than has been available heretofore in any American university.

The Southern Regional Education Board established by the legislatures of 14 southern states to promote the development of professional and technical education in this region has designated North Carolina State College as the center for undergraduate instruction in pulp and paper manufacture in the south. The collaboration of this interstate education board, coupled with the enthusiastic support of a large group of southern pulp and paper manufacturers, guarantees the early development of this school as a major source of technical personnel for the southern pulp and paper industries.

Water for Papermaking, Past, Present, and Future, C. A. SNAVELY

Public attention to the water problems and methods of water use in the United States is on the increase. The status of water in the national economy is now fairly well understood by the layman. In former years, only the technically trained personnel in industry and some enlightened municipal and other government officials were in a position to view the over-all water-use picture in its "proper perspective."

The connotation "proper perspective" is ambiguous. We are in a period of rapid technological and social change and the average citizen's concept of fair water use is changing. We must attempt to visualize what that concept will be 10, 20, and even 30 yr. from now, in order to plan adequate water supplies for future industrial needs.

Stream-pollution problems are now important limiting factors on water supplies. The pulp and paper industry like the steel and the steam-electric power industries, is an example of transitory use of large quantities of water. Most of the water must be upgraded after it is taken into the mill. In a pulp or paper mill it is degraded during passage through the mill. Limits on discharge of this degraded water are responsible for many changes in water practice within the mill. This in turn affects water needs at the intake.

In considering water needs for the future, numerous factors are important. The stream-pollution situation is already being faced realistically, but will become even more of a problem. Regardless of changes in the national needs, the long-range view indicates closer control over water supplies and uses. Technological advance is the most important factor affecting future water needs in the pulp and paper industry. We can be sure that water needs will not increase as rapidly as total production and that the cost of water will be relatively less.

Centrifuge Analysis for Suspended Solids in White Water, E. A. MASON AND R. R. QUINCY

A rapid method for the determination of the suspended solids content of white water streams has been developed using a small hand-powered centrifuge and calibrated glass tubes. This method is recommended for use in performing routine checks on the main waste streams in pulp and paper mills and in locating the source of losses which develop. The effects of consistency, filter-to-fiber ratio, and tube shape have been investigated. Calibration curves for various types of pulp and furnishes can be established easily.

Application of Ground-Water Hydrology to the Development of Industrial Water Supplies, NICHOLAS A. ROSE

During the past 25 years the use of ground water has increased tremendously throughout the United States. This trend to develop more and more ground water in ever increasing quantities has created many complex and intricate hydrologic problems. Fortunately, ground-water technology has kept pace with the increasing complexity of the ground-water problems. Quantitative methods including mathematical, geophysical, and geological techniques have been devised. Probably the most important scientific tool yet developed for use in ground-water hydrology is the Theis nonequilibrium formula. Practical applications of this formula have been employed throughout the world in the determination of drawdowns of water levels caused by given rates of pumping. Another important technique is the electrical loging of wells to differentiate the type of formation encountered in drilling and the quality of water contained in the water-bearing strata. These and other techniques and methods are being used to great advantage in investigations of ground water for industrial plants, municipalities, and irrigation projects.

Water Use Questionnaire Report, STEPHEN BERGEN

In November, 1952, the Water Committee of the Technical Association of the Pulp and Paper Industry and the Conservation Foundation forwarded to all pulp, paper, and paperboard mills in the United States a questionnaire on the use of water. This questionnaire was quite detailed, consequently it will take time to correlate the complete answers for a report to the industry. This interim report is being made to indicate the progress made to date.

How Do TAPPI Standard Methods Fit the Needs of Hardboard Producers? WAYNE C. LEWIS

The production of hardboard in the United States is increasing at a rapid rate. Significant in the increase in production is that the number of producers is increasing at a more rapid rate than volume because most of the newer facilities are small as compared with prior producers. Hardboard manufacturing processes are reviewed with emphasis on the type of tests needed to maintain quality at different stages of production.

The Peculiarities of White Oak Hardboard Stock, S. L. SCHWARTZ

White oak chips were converted to pulp by means of an Asplund defibrator. In the conversion of this pulp to wet-process hardboard a number of peculiarities were observed which were

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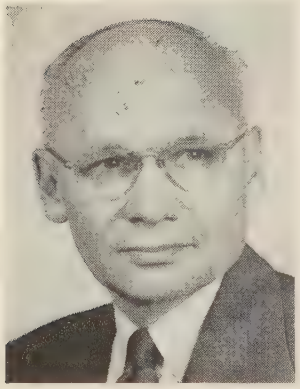

H. F. Lewis, The Institute of Paper Chemistry; Chairman, Fundamental Research Committee

J. F. Langmaid, Jr., S. T. Warren Co.: Chairman, Statistics Committee

attributed to the extraneous components of oak, most likely tannins and tanninlike substances. Disproportionately large amounts of affixing agent, alum or ferric sulphate, were required to set the size. Furthermore, the amount of size, rosin, or paraffin, required to secure optimum flexural strength appears to lie in the range of 0.75 to 1.0%. Lower amounts of size, though adequate to impart water resistance to the hardboards, brought about lower flexural strengths.

Washing of the pulp with hot water to remove soluble tannins and tanninlike substances reduced the amount of affixing agent necessary to set the size from 6 to 2%, moisture-free pulp basis; however, higher flexural strengths were obtained at the higher affixing chemical to size ratios.

The Evaluation of Furnishes Used in Producing Insulating Board, C. K. Textor

An investigation was undertaken to determine the relative merits of board furnish evaluation made with $^1/_{16}$-in. thick handmade boards (by a modification of TAPPI Standard T 205), as opposed to the procedure of a suggested method (T 1001 sm) in which handmade boards $^1/_2$ in. thick are produced.

Eleven board furnishes, some experimental, some from actual commercial operations, were tested by the two methods.

The modification of Standard T 205 is quicker, requires less stock and less equipment. The results of the two methods are about equally reproducible and there is not much difference in them for the evaluation of tensile and transverse strengths.

From all other viewpoints, the Suggested Method T 1001 promises to be far superior. It can be used to get an accurate idea not only of the strength of finished board, but also of its appearance, its density, and the moisture content of the sheet entering the driers; in fact, most any specification for finished board can be constructively studied with the procedures of Suggested Method T 1001.

Evaluation of the SFMC-TAPPI Drainage-time Tester, C. E. Hrubesky and Jules J. Perot, Jr.

Two drainage-time testers manufactured to meet the requirements described in TAPPI Standard T 1002 sm-51 give comparable results on a wide range of insulating-board stocks if the pulps are given identical treatment. Stirring pulps with the TAPPI or other high-speed propeller-type stirrer alters the pulps sufficiently to give different drainage rates with different times of stirring. This effect appears to be more pronounced with slow pulps than with fast or normal pulps.

Evaluation of Refiner-Plate Designs Used for Experimental Processing of Hardboard Stocks, H. Dale Turner

The effects of dissimilar plate designs used in a disk refiner for processing hardboard pulp upon stock drainage time, board strength, and energy consumed in milling the stock were investigated by means of a 5-hp. single-rotating-disk attrition mill. Experimental data involving three plate designs and various milling conditions are presented in tabular and graphical form.

The ratio of hardboard blending strength to energy consumed in milling the stock, herein defined as the energy index, is a significant measure of plate performance. Thix index is essentially constant for a single plate design throughout a wide range of pulp quality, but dissimilar designs may show index values differing by as much as 400%.

The effect of plate design on drainage time is large; a range of 300% in drainage time was observed for equal-strength boards made from pulps which were refined with dissimilar disk patterns.

The effect of plate rotation direction upon stock drainage time and board strength is significant and measurable.

Application of Refining Energy Index Concept to Experimental Evaluation of Strength-Yield Relations for Hardboard Stocks, H. Dale Turner

Steam-cooked Douglas-fir pulps in yields ranging from 68 to 96% were refined for hardboard stocks in a 5-hp. single-rotating-disk refiner.

Data for time-temperature-yield relations are presented, together with pulp drainage times and corresponding hardboard strength values.

The ratio of hardboard bending strength to energy consumed in refining, called the energy index, is shown to be significant in rationalizing a wide dispersion of strength-yield data. The energy index increases directly with decreasing yields. The theoretical energy demand-strength relation indicates a rapid decrease in energy consumption with decreasing yields down to approximately 85% but a comparatively minor decrease for yields below 80%.

A Lignin-Carbohydrate Bond in Wood, Elwin E. Harris

Evidence pro and con for a lignin-carbohydrate bond in wood is reviewed. When attempts were made at the Forest Products Laboratory to fractionate wood into carbohydrate and lignin by grinding and sifting, lignin was concentrated in the very fine powder, but all fractions contained substantial quantities of lignin. Wood of maple, aspen, and spruce was treated with methanol and hydrochloric acid under conditions similar to those used to study the reactive chemical groups in native and purified cellulose. A large part of the hemicellulose dissolved. About 70% of the lignin in the hardwoods and 24% in the spruce dissolved in 20 volumes of methanol in 48 hr. Treatment of wood with a 17$^1/_2$% solution of alkali dissolved the hemicellulose of wood and made about 70% of the lignin in the hardwoods and about 30% of the lignin in the spruce soluble in methanol after removal and neutralization of the alkali.

Dye Adsorption on Wood Pulp. III. Effect of Pulping and Bleaching Variables on Specific Dye Adsorption, E. F. Thode, A. J. Chase, S. S. Majmudar, and D. R. MacKinnon

Dye adsorption studies have been conducted on commercial and laboratory prepared acid and alkaline pulps. Results show that, when a beater test is run on a given pulp, specific dye adsorption bears a definite relationship to the physical properties of handsheets. (This statement generalizes a conclusion previously reported for a single grade of acid pulp only.) Moreover, during bleaching and drying of pulp the change in specific dye adsorption follows closely on changes in physical properties.

No direct correlation between specific dye adsorption and physical properties is found when a hardwood pulp is compared with a softwood pulp. Neither may a clear-cut comparison of results be made between alkaline and acid cooks on the same species of wood. Since external surface is not believed to be the sole criterion of strength as between pulps of differing origins, this result is to be expected. Even though a direct correlation is not obtained, the usual trend of the data observed is that high strength of a pulp is accompanied by high dye adsorption.

Converting to High Capacity Pulp Screens, W. C. Stevens, A. T. Lynch, and P. W. Estes

The Cowan centrifugal pulp screen, the latest design of a free tailings discharge-type rotary screen, was introduced into one mill with savings in power, increase in capacity, and cleaner pulp. The use of phenol coating is described for cleanliness and increased screen plate life. Operating procedures are indicated and maintenance problems encountered in this mill are described.

Acid Pulping with Sodium Sulphate Liquors, George A. Richter

Although it is readily demonstrated that wood can be successfully pulped with water solutions of sulphur dioxide alone, all commercial acid sulphite pulping is currently based on digestion of wood chips with liquor that contains both free sulphur dioxide and a bisulphite. Preferred use of bisulphite in the industry is explained by more practical operation, since in order to produce an easily bleachable pulp with sulphur dioxide alone it is necessary to employ high concentrations (15 to 25%) and to cook at high pressures and for longer periods of time than is found necessary when calcium or other bisulphites are present in the liquor.

The function of the bisulphite is not completely understood. There is considerable evidence that its main purpose is twofold: first, to protect the cellulose against excessive hydrolysis by the sulphurous acid and by the sulphonic acids formed in the sulphonation of lignin, and second, to prevent loss of reactivity of lignin which can occur readily in the early stages of the cook in the absence of combined sulphite, particularly with sulphur dioxide solutions containing less than 10% SO_2 and at temperatures above 100°C.

Ordinarily, the bisulphite is of a calcium base, although in certain special cases magnesium, sodium, and ammonia-base liquors have been used for this purpose. Reuse of the inorganic content

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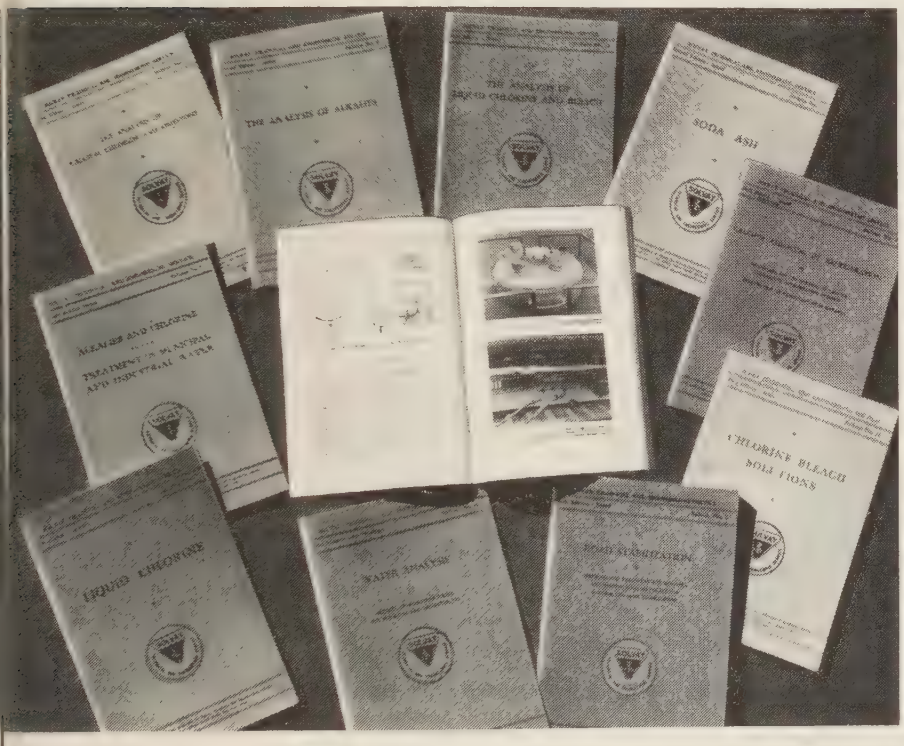

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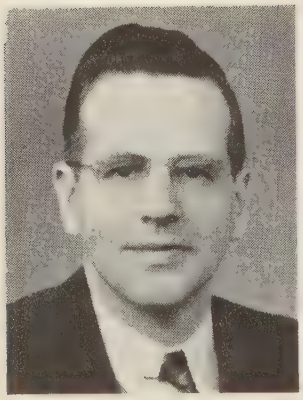

E. N. Poor, Hudson Pulp & Paper Co.; Chairman, Nonfibrous Raw Materials Committee

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of the spent liquor for successive pulping of new wood batches requires a special recovery system since furnace ash or smelt that results on burning of the evaporated liquor must be of a composition that lends itself to a practical reconversion to a bisulphite. One such recovery system is currently in operation with a magnesium-base cook liquor. With sodium-base acid, a reducing type of furnace would be advantageous if means were provided for separation of sulphite from carbonate and with subsequent conversion of the carbonate to sulphite. In such a system provision can be made for a conversion of sulphide to sulphite, or for means of using the separated sulphide in an adjoining kraft pulp operation. Such recovery processes have been engineered but have not been put into actual use in this country.

In U. S. pat. 1,427,125 the author disclosed a pulping procedure that depends on the digestion of wood in liquors that contain free sulphur dioxide and soluble sulphates. It was shown that a satisfactory substitution of the sulphate for the sulphite can be accomplished without resorting to abnormally high percentages of free sulphur dioxide and with cooking pressures and time periods not far different than those ordinarily employed in orthodox bisulphite pulping. It was also revealed that the quality of resulting pulp is equal to that obtainable with bisulphite liquors and that a sulphate-containing cook liquor offers a simpler means for chemical recovery than is possible in the case of the prevailing sulphite cook procedure.

Much experimentation has taken place since the early disclosure, and work has been extended to include other buffer materials than sodium sulphate. Results of some phases of this investigation are given. Working theories to explain the process are offered.

Miscellany on Ammonium Bisulphite, Gordon A. Crowe

The advantages of the ammonium bisulphite pulping process are mentioned briefly. The merits of an ammonia test run are discussed, and the results of a recent test presented. Equipment modifications for either a temporary or a permanent installation are discussed. Recommendations are submitted for storing and handling ammonia. Data are presented from a dynamic corrosion test in which brass was subjected to ammonium bisulphite solutions.

Sulphur Usage and Distribution in Sulphite Pulping, C. H. Anderson

A set of self-consistent data relating yield of unbleached sulphite pulp and sulphur consumption and also yield and distribution of sulphur among the process streams has been obtained by pilot plant operation under conditions which permit application to full-scale operations provided proper allowance is made for differences in such conditions as wood species and combined SO_2 in cooking acid.

Western hemlock chips were cooked in calcium-base acids containing 1% combined and 5% free SO_2 to obtain pulp ranging in yield from about 40 to 50%. Duplicate series were made with and without recycled relief. The effect of varying the cooking temperature was demonstrated at the lowest and highest yield levels.

Sulphur input was measured by analysis of the cooking acid. Output was measured as the sulphur content of liquid and gaseous relief, spent liquor after flashing of 5 p.s.i., gas flashed from liquor, and digester charge after draining spent liquor. The flashed spent liquor was stripped for additional sulphur recovery by direct evaporation equivalent to a steam usage of 700 to 1000 lb. per ton of pulp.

The distribution of sulphur among the process streams was tabulated and illustrated graphically in relation to pulp yield for each cook. Sulphur consumption, defined as the sum of the total sulphur remaining in the spent liquor after flashing or stripping plus that remaining in the digester after draining, plus sulphur unaccounted for, was calculated.

Recycling or organics in relief or varying maximum temperature had little or no effect on sulphur consumption.

As unbleached pulp yield was increased from 40 to 50%, sulphur consumption (without stripping) decreased from about 265 to 170 lb. per air-dry ton of pulp. At 46% yield, sulphur consumption amounted to about 180 lb. per ton. Sulphur consumption was reduced 10 to 20 lb. per ton by stripping the flashed spent liquor.

The sulphur consumption at 46% yield, as found in this experiment (180 lb. per ton) falls between a theoretical value based on the sulphur content of lignosulphonic acid (160 lb. per ton) and the reported experience of Canadian pulp mills (av. 235 lb. per ton).

Spent Sulphite Liquor Studies. IV. Use of Spent Liquor in Reconditioning Asphalt Road Surfaces, Walter Sherman, George Bublich, Neal Rice, G. K. Dickerman, Groff Collett, and A. J. Wiley

Reformation of worn asphalt or "black top" road surfaces has been found to be promoted by inexpensive applications of spent sulphite liquor during regrading operations. Practical road tests in Wisconsin have shown that secondary roads in advanced stages of raveling can be reworked with a grader to pulverize and redistribute the old surface material after which spent sulphite liquor applications from tank trucks serve to accelerate the formation of a new and tight bituminous surface within a few days under normal traffic. Such reformed surfaces, without use of new asphalt binding material, have been observed to stand up well after a year of service through a Northern Wisconsin winter and without apparent damage from Spring break-up. Methods used in the road trials to date are described.

Laboratory trials are being carried out to confirm the reformation characteristics of sulphite liquor application to test material taken from old roads. Deformation and shear tests are in progress. Preliminary strength tests (Marshall stability) so far made tend to confirm the experience of the road trials in terms of good load bearing capacity.

Some observers are of the opinion a transitional and preliminary softening reaction of the broken asphalt aggregate occurs after application of spent sulphite liquor. Such a reaction might contribute in part to the reformation characteristics, but laboratory evaluation of these phenomena has been difficult to carry out and to confirm.

Optimum conditions for spent liquor application are under study by the Sulphite Pulp Manufacturers' Research League, Inc.

Sulphite Digester Heater Tube Cleaning Survey, J. M. Wilcox and W. R. Barber, Jr.

Results are tabulated from a TAPPI questionnaire sent to 91 sulphite pulp mills, in an attempt to correlate operating conditions with digester heater scale formation and cleaning methods. Of 53 replies, only 13 reported they were using digester heaters; and conditions varied so widely that no definite conclusions could be drawn. Various comments made by those reporting, both with and without heaters, are also included.

Development of 65% Yield Sulphite for Newsprint Furnish, Frank P. Silver and L. R. Beath

Rising wood costs increasingly emphasize the importance or higher yields in chemical pulps. A mill-scale pilot plant which has produced news-grade sulphite pulp of 63 to 65% yield for nearly 3 yr. is described, together with operating conditions and results. Extensive commercial tests proved that the pulp was entirely satisfactory for newsprint furnish, and that newsprint made with it is fully equal to that made with normal yield sulphite. A brief description is given of the plant now under construction to provide full sulphite requirements at high yield sulphite for manufacture of over 700 tons per day of newsprint.

The Determination of Total Nonaqueous Constituents in Pulp Mill Liquors. II. Application to All Types of Residual Pulping Liquors, J. H. Phillips and M. M. Rubright

The need for more reliable laboratory data for use in establishing accurate heat and material balances in the various pulping processes in the paper industry is emphasized. A definition for "total nonaqueous constituents" is given. The suggestion is made that such a term be used in place of "total solids" so as to

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include volatile organic constituents and in order to give a more usable value for engineering calculations.

A method for the determination of total water in liquors is described. This method is a modification of the well-known Karl Fischer titration and was previously proposed by the senior author for analyzing magnesium-base liquors. The method has now been extended and has been proved satisfactory for all types of residual pulping liquors.

Comparison of results obtained by this method and oven drying procedures show differences which are directly proportional to the amount of volatile constituents lost and water retained by various liquors during oven drying. Results of comparisons between this method and oven drying procedures for all types of liquors are reported.

It is felt that the use of this method will demonstrate its advantages over oven drying techniques in obtaining a more true evaluation of the water content of residual liquors, and that it be considered a new analytical procedure for routine liquor analysis.

We suggest, in view of its reliability as a true measure of moisture, that this method be given consideration as the standard method for determining the moisture content of residual pulping liquors, including sulphate, semichemical, and for all forms of sulphite liquors.

Improved Flute and Advantages of Chrome Plating Contours of Corrugating Rollers, Arthur Werner

The principal objective of the new style tooth contour for corrugating rollers takes into account the fact that various types of corrugating medium being used are heavier than 9 point, that plenty of clearance must exist for variations in caliper on the corrugating medium especially since chrome plating may be added to the rolls later, and finally the tooth form should be consistent with obtaining the highest values in flat crush tests. Corrugating medium is usually 0.009 in. caliper but may run as thick as 0.018. The chrome plating is usually no greater than 0.002 in. but the flute contour design must accommodate this wide variation in medium thickness.

If only a limited amount of clearance exists to accommodate 0.009 medium, any increase in thickness of such medium will prevent the corrugating rollers from bottoming when brought together under pressure and this will introduce variations in flute height or what is commonly known as high and low flutes.

Now, with respect to obtaining maximum values for flat crush tests of corrugated board, it is essential that the radius at the tip and at the trough should be so designed that the curvature at these points is held to a minimum. This is necessary in order to insure as straight a side or diagonal of the flute as is possible. Larger radii at these points have a tendency to bend under load thereby starting premature collapse. Another advantage of ample clearance in flute contour design is that there is never any tendency to apply pressure on the side of the tooth, thereby eliminating the possibility of tearing or cracking the medium at this point.

The life of steel corrugating rollers for the present remains a metallurgical as well as a paper mill problem. In the manufacture of paper, it seems to be quite impossible to eliminate small quantities of very fine sand and glasslike particles which give an abrasive quality to the paper and through continued running through the corrugating rollers, tends to wear down the crown of the rollers and the height and diameter of the flutes. The metallurgical aspect has to do with the resistance of the corrugatng rollers to such abrasion.

The great advantage of chrome-plated rolls is the fact that the chromium-coated rollers are run only up to the point where the chromium coating is almost removed by the abrasive quality of the paper. After this the rolls are taken out and again chromium plated and this operation is performed repeatedly without even reducing the original form of the chrome-moly rollers or reducing the original diameters.

Another reason for the desirability of chrome-plating corrugating rollers is the fact that at higher speeds the life of a pair of unplated rollers is less than half the life formerly received when slower speeds were used, this life being measured in terms of millions of lineal feet of corrugating medium run over the roll. The increase in machine speed alone cannot account for this reduced life but speed in the presence of foreign abrasive material in the medium has had marked detrimental effects on the life of corrugating rollers.

In order to accurately record the results of corrugating rollers in use, particularly with respect to their life as compared to reduction in diameter and flute height, rolls should be accurately measured before being put into service and measured periodically while in service for comparative results.

Control Methods Developed for Stock Preparation System, J. H. Pearson

Several methods of control have been designed for stock preparation systems, it is the purpose of this paper to discuss a few of these designs.

The control methods to be discussed are as follows: (1) water regulation in cleaning systems, a new approach to consistency control in cleaning systems; (2) water control in batch systems, an outline of the more popular water measuring systems; (3) stock capacity control at jordan headbox (this system outlines a method of controlling jordan throughput and eliminating headbox overflow); (4) special Hydrafiner control for Duocycling system, a new method for interposing batch refining in a continuous process; (5) suction couch control, a new method for resetting an automatic jordan control in accordance with suction couch variations.

A Suggested Test Method for the Determination of the Efficiency of Reject Removal, George B. Nicholson, Jr.

Present methods for the determination of the efficiency of reject removal are unsatisfactory, principally because of the difficulties of obtaining a suitable and representative sample.

A new method of testing is proposed which employs the principle of continuous sampling in order to provide a large and uniform sample. This, in turn, is processed to remove the rejects, also on a continuous basis, so that (1) a large amount of pulp is not wasted by sampling and (2) an excessively large sample is not obtained for further processing.

The method depends, essentially, on the use of duplicate equipment processing "before" and "after" samples from the reject removal equipment or process so that inefficiencies will be canceled. Each of these duplicate systems consists of a small pump, a cyclone with free flowing discharge, and a secondary settling device.

In the absence of a mass of data obtained over a long period of time, it is not possible to define the exact limits of usefulness of this method nor the exact limits of accuracy but on the basis of present data it would appear that these would be in conformance with normal test procedures and for certain applications it is a proved method.

The Mechanical Properties of Paper—Part II, Geoffrey Broughton and James P. Wang

Further work on the Instron tensile tester using papers immersed in a variety of organic liquids and water is reported. The shape of the stress-strain curve and work to rupture are related to the hydrogen bonding power of the liquid.

The Organization of Small Engineering Laboratory, A. W. Pomper

Much of what has been written about industrial laboratories is concerned with large organizations. When we consider that almost 99% of all manufacturing firms employ less than 500 persons, the need for consideration of the problems of smaller laboratories becomes evident.

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Organization and management control is necessary in a small laboratory in order to assure that the technical talents will be used to the best advantages of the company, that the operations will not consist almost exclusively of urgent short-range projects with neglect of more important but less pressing long-term work, that money will be spent more effectively, and that results will be retained for future reference.

A laboratory should be established if sales are falling off or if competitors are producing better products or selling at lower prices. The functions of the laboratory may include research, development, design, technical service, testing, quality control, and even some aspects of sales and advertising. Research budgets for small companies average about 2% of the sales volume, according to a reference cited. Personnel problems are usually the responsibility of the director, and any time spent on this phase will be amply repaid. Equipment requirements vary greatly from one organization to another, but in any case sufficient instrumentation should be provided. Adequate space is also important.

The control of a small laboratory is generally quite simple, but responsibility and authority must be delegated if the director is to have time for more than routine administration. Written project requests are common, with approval required by the director. Prescribed report forms aid in assuring that all pertinent information is recorded for future reference. The proper balance between freedom of individual effort and prescribed procedure must be maintained.

Explosions in Chlorine Absorption Systems, E. A. Mason, W. C. Bauer, and R. R. Quincy

During a study of explosions occurring in absorption systems used for the preparation of chlorine bleaching solutions from cell gas, the lower explosive limits for mixtures of hydrogen, chlorine, and air were determined. These limits were found to be determined almost completely by the concentration of hydrogen. Mixtures containing more than about 5% hydrogen are above the lower explosive limit regardless of the relative amouts of chlorine and air present.

Gas samples were also taken from various parts of the absorption system used to produce chlorine water and hypochlorite bleach solutions. Analysis of these samples showed the presence of explosive mixtures at some points in the system. These explosive mixtures were traced to the stripping of chlorine from the feed gas which originally contained small amounts of hydrogen and air. Explosions in the absorption system appear to be related to the production of chlorine water and may have been ignited by static electricity.

The use of an air bleed into the system and of an antifoaming agent in the spray water have been successful in eliminating serious explosions.

On the Mechanism of Sulphur Dioxide Absorption in Aqueous Media, R. P. Whitney, S. T. Han and J. Lawler Davis

This paper discusses the absorption of sulphur dioxide in several aqueous media of interest in the pulp and paper field.

When the absorption is conducted in a packed tower, and interpreted in the light of the two-film theory, it is shown that the absorption mechanism varies greatly with the characteristics of the absorbent. For the sulphur dioxide-water system, both film resistances are known to be important. When the absorbent is a strongly alkaline sodium carbonate solution, the resistance is essentially all in the gas film. In sodium bicarbonate and sodium sulphite solutions, the controlling resistance shifts toward the liquid film. The implications of these conclusions in design are pointed out.

The Evaporation of Ammonia-Base Waste Sulphite Liquor and Recovery of Ammonia, L. C. Jenness, R. E. Durst, and E. F. Thode

Heat transfer coefficients to ammonia-base waste sulphite liquor in an experimental, vertical, long tube, forced circulation evaporator have been determined. Variable velocities of liquor in the tubes and an approximately constant temperature driving force were employed. Concentrations ranged from 15 to 40% solids.

The evaporator consisted of an 8-in. diameter steam chest surrounding three tubes $1^1/_2$ in. in diameter and 24 ft. long, surmounted by a vapor space. Liquor was recirculated from the vapor space to the tubes by means of a pump and water vapor was condensed in a spray condenser.

Over-all heat transfer coefficients varied from about 150 to 300 B.t.u. (per hr.) (sq. ft.) (°F.) as the solids content of the liquor varied from 15 to 40% and as the linear velocity of liquor in the tubes varied from 1 to 5 f.p.s. Within the range of this investigation the size of the coefficient was directly proportional to the apparent velocity of liquor within the tubes and inversely proportional to the concentration of solids.

The recovery of ammonia has been determined experimentally by the evaporation of mixtures of ammonia-base waste, sulphite liquor and waste liquor. The liquors were mixed in ratios of 1:1, 2:1, and 4:1 of kraft liquor to sulphite liquor previous to evaporation. The percentage of available ammonia recovered in the condensate from a surface condenser was found to vary from 60% to virtually complete recovery.

No objectionable precipitation of solids or fouling of the tubes was observed. Serious pit corrosion of the stainless steel vapor space, particularly where clad to mild steel, was experienced during the evaporation of sulphite liquor alone.

Brown Stock, Washing Efficiency—Displacement Ratio Method of Determination, J. K. Perkins, H. S. Welsh, and J. H. Mappus

A method is presented for use in forcasting the efficiency of, or the analysis of, a multistage countercurrent, rotary vacuum filter, brown stock washing system. Equations have been derived and empirical data collected which indicate that the efficiency of a system may be expressed by the single equation $Sm = \pi R(1 \rightarrow m)\, S_b$, where Sm = % solid in the liquor leaving with the washed pulp, S_b = % solid in the blow liquor, and $\pi R(\rightarrow m)$ = that product of R factors from R_1 to R_m. (One for each stage.) These R factors are a function of the displacement ratio and dilution factor in each stage.

The displacement ratio can be derived theoretically in terms of the total weight of liquor in the pulp leaving the washer, W_p, the dilution factor D, and the number of applications, n, of shower liquor on a given stage. This ratio between the weight of shower liquor in the pulp leaving the washer, W_s, and W_p is the displacement ratio W_s/W_p and is equal to $1 - \{{}_nW_p/[(n+1)W_p + D]\}^n$. This equation leads to a correlation between the dilution factor, D, and the displacement ratio W_s/W_p or its equal $(S_v - S_s)/(S_v - S_l)$, where S_v = % solid in vat liquor, S = % solid in liquor leaving with pulp, and S_s = % solid in shower liquor.

Use of displacement ratio-dilution factor relationships requires establishment of empirical curves for the particular conditions of washer operation. Different types of pulps, different specific loadings, make this necessary. The general displacement ratio curve is:

$$\text{D.R.} = K\left\{1 - \left[\frac{{}_nW_p}{(n+1)\,W_p + D}\right]^n\right\}$$

where K is a displacement constant, a function of the pulp characteristics, shower temperature, etc.

Thus, a method is available expressing the washing accomplished by the showers and its use in combination with a group of washer factors. This method of handling washer performance appears to be sound both theoretically and practically.

The Fundamentals of Control Charts, Charles A. Bicking and Richard T. Trelfa

There are some limitations to the direct application of control

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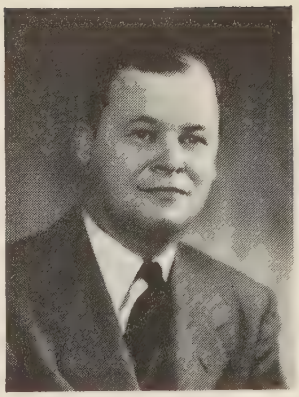

J. J. Forsythe, Jr., International Paper Co.; Chairman, Deinking Committee

charts to production control in the pulp and paper industry. However, in the past few years, more than 50 articles on statistics have appeared in journals serving the trade. Many of these have involved variations in the use of conventional control charts. This is evidence of substantial utility to the industry of the control chart as a method of analyzing data and as a means of process control after proper control points have been identified by analytical means.

One of the major problems to be overcome in any particular application is the rational subgrouping of data to arrive at appropriate limits for the chart. The choice of grouping depends on more information than is usually on hand. This is being overcome as more is learned about the variability of paper testing and sampling techniques. New types of measurement devices, such as beta gages, are helping to accumulate basic variation information needed for intelligent chart control.

Inherent in the success of any plan of control is a method for obtaining positive action to correct causes of lack of control as they occur. This means that the limits must be established on "economic" grounds as well as that supervision must be ready to make changes upon the advice of the quality control engineer.

Finally, if the charts are intended as a means of currently controlling the output of a machine, they must be simple enough for any operator to use and understand. The advantages of the quality control program must be kept before the whole organization as constantly as any other important program, such as safety.

Surface Properties of Rosin Size Precipitates. I. Factors Affecting Formation of Resin-Aluminum Sulphate Complex, E. F. Thode, J. F. Gorham, and R. H. Atwood

Results of electrophoretic mobility determinations on rosin-aluminum sulphate complex are presented as a means of evaluating factors affecting the surface potential of size precipitate.

In the absence of foreign materials, the original negative potential of rosin is found to change rapidly to a positive value with the addition of small amounts of aluminum sulphate. At about a one-to-one ratio of aluminum sulphate (anhydrous) to rosin size a maximum positive value is obtained. A subsequent hundredfold increase in aluminum sulphate concentration has but little effect on this value.

Comparison of complex suspensions that have been subjected to violent agitation with those not so treated indicates that, in the absence of foreign materials, the net potential of rosin-aluminum sulphate complex is decreased by such agitation. A hypothetical explanation of this phenomenon, based on the possibility of ion entrapment, is presented.

Correlation of mobility results with a limited amount of data on controlled sizing experiments indicates substantial agreement with the theory that the attraction of unlike charges on negative cellulose and positive rosin-aluminum sulphate complex is a major factor in sizing. This theory is but slightly different from the electrostatic theory of Oswold and Lorenz.

Surface Properties of Rosin Size Precipitates. Part II, J. F. Gorham and E. F. Thode

An investigation to determine the effect of foreign ions on the net surface potential of rosin-aluminum sulphate precipitate has been carried out by means of electrophoretic measurements.

It was found that the presence of sufficient alkaline-earth sulphates tends to decrease the mobility of rosin-aluminum sulphate complex; the decrease in mobility of the complex is proportional to the concentration of foreign sulphate below 0.01 molal. This decrease correlates with a decrease noted in sizing effectiveness upon addition of foreign sulphates to size systems.

In the case of foreign chlorides it was found that the mobility of the complex increases in the presence of many metallic chlorides, within an upper concentration limit of 0.004 molal in most cases. Within appropriate limits, the mobility is a logarithmic function of the foreign cation concentration. The mathematical expression of this function has the general form: $d\mu/dC = K/C$, where μ is the electrophoretic mobility, C is the concentration of foreign ion, and K is an empirical constant evaluated for a given ion. This function is similar in form to an equation for ion adsorption derivable from the Nernst half-cell concentration potential theory. As a result of such similarity, it is tentatively concluded that the variation in mobility noted in the case of addition of metallic chlorides is caused, in part, by the preferential adsorption of the foreign cation on the rosin-aluminum sulphate complex.

Experiments with the addition of sodium salts of some high valence anions, which have been found to have a drastically adverse effect on sizing, demonstrate that such materials also bring about a rapid drop in the electrophoretic mobility of size precipitate. As concentration of the foreign anion increases, the positive charge on the size precipitate drops rapidly and soon becomes negative. These results lend further credance to an electrostatic theory of sizing.

The Removal of Dirt and Gases from Pulp Stock Suspensions, Horace Freeman and John D. Boadway

The presence of gas in papermaking stock has for some time been considered undesirable. This gas is found in pulp suspensions in three states; as gas bubbles, as gas in solution in the liquid, and as gas adsorbed on the surface of fiber. Gas removed from stock by boiling under vacuum proves to be abnormally high in carbon dioxide due to the high content of this gas adsorbed on fibers.

It is the gas existing as bubbles which is objectionable in papermaking due to its tendency to float and flocculate fiber and pitch. However, in order to achieve the removal of gas in this form and to ensure that no further bubbles are produced it is necessary to remove a large proportion of the total gas in the stock. A recent refinement to the art of papermaking is the removal of considerable gas from stock by spraying into an evacuated tank. A new method of gas removal has been developed utilizing the Vortrap for this purpose.

It has been found that if the tangential velocity head be raised and the pressure reduced within the separating tube of a Vortrap, the stock may be kept on the wall and a vacuous core exist in the center. Due to reduction in pressure, gas in the stock forms bubbles, which, together with any bubbles which may have initially existed, are displaced to the central core by centrifugal force. Gases may hence be removed from stock by applying a vacuum pump to the core of the new Vortrap. The changes in hydraulic conditions made to achieve this result are also favorable for better dirt separation. A modified Vortrap has hence been developed which gives highly efficient separation of gases and dirt simultaneously. This device should prove a valuable piece of equipment not only to the paper industry but in numerous other fields.

Use of Aluminum Chloride in Melamine Treated Papers, F. W. Boughton and K. J. Mackenzie

The use of melamine resin for preparing high wet-strength papers has gained general recognition in the trade. The advantages of using aluminum chloride in place of aluminum sulphate for precipitating the beater size when using melamine resin has not been adequately presented in the technical literature.

Although the price of aluminum chloride is several times greater than aluminum sulphate a considerable saving in paper manufacturing costs may be realized. This is accomplished by being able to make a drastic reduction in the melamine resin furnish without any sacrifice in wet strength. Data, represented by actual machine production and showing the advantages of aluminum chloride with melamine resin treated papers, are given. Wet-strength data are given for both high alpha-cellulose and bleached rag furnishes. Typical results show that while an

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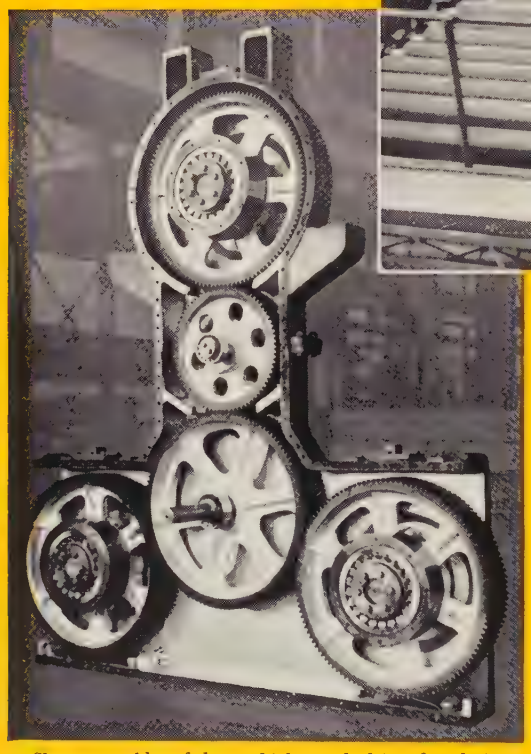

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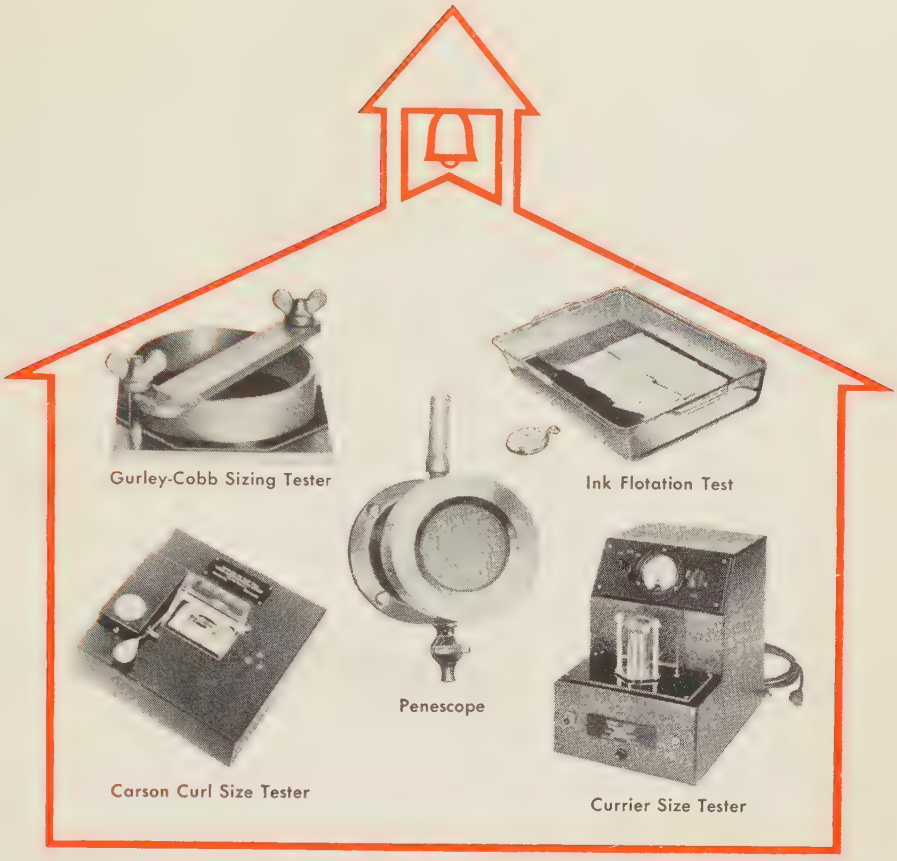

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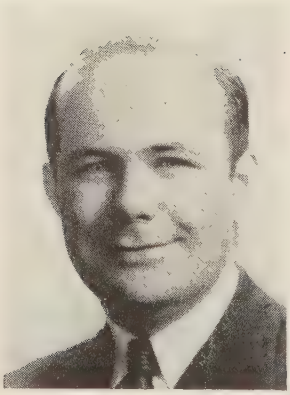


N. R. Phillips, Champion Paper & Fibre Co.; Chairman, Papermaking (Fourdrinier) Committee

E. R. Schafer, Forest Products Laboratory; Fibrous Materials Testing Committee

aluminum sulphate system, producing paper with a wet burst of 8, uses 3½% melamine resin added after the jordan, a comparable wet-strength may be realized with only ½% resin when an aluminum chloride system is used.

Aluminum chloride is used as a replacement for aluminum sulphate to precipitate the beater size on the basis of an equivalent Al_2O_3 content in the furnish. The headbox pH is maintained at approximately 4.5. Aluminum chloride solution is available at a 50% concentration (based on $AlCl_3$-$6H_2O$) in rubber-lined tank cars.

The results of this work have led to the adoption of aluminum chloride for precipitating the beater size in all regular production involving the manufacture of wet-strength papers with melamine resin. A system for the storage and distribution of the aluminum chloride solution using all rubber-lined storage tanks and piping is briefly discussed.

Mannangalactan Gums: The Mechanism of Retention by Paper Fibers, N. S. Gruenhut

A short historic review points to the use of gums or mucilages in the paper industry to permit increases in machine speed and bursting strength of paper.

The retention of mannangalactan gums, as well as their borate complexes is determined by viscometric measurements.

Formulations of gums to achieve good dispersion as well as retention are discussed and data shown to demonstrate their advantages over straight gums. Gum retention is a function of the gum concentration. The gum-borate complex shows a certain independence of the gum concentration.

A theory for the mechanism of retention is presented, based primarily on hydrogen bonding. It is concluded that a linear gum will align itself to the threadlike cellulose molecule and be adsorbed on the surface, from which it can be washed out again to a certain extent, while the more branched modified gum molecule, due to crosslinking properties, will be anchored more securely within the cellulose molecule in addition to adsorption on the surface.

Significance Tests and Analysis of Variance, F. R. Sheldon

The common statistical tests of significance will be discussed, with examples, in relation to their fundamentals, their uses, and misuses. The basic principles underlying the analysis of variance will be explained and examples given of its use in simple applications. The advantages of this statistical technique applied to more complex problems will be outlined briefly.

Machinery to Manufacture Glued Lap Joint Type Containers, Ray A. Thompson

Back 20 years ago corrugated container manufacturers were experimenting with a glued lap joint similar to that used for folding cartons. There appeared to be no adhesive available at that time cheap enough to be economically sound, and at the same time be moisture proof.

Not until late in 1949, did the experimentation undertaken by several different concerns convince the railroads that glued lap corrugated containers were at least equal to stitched or taped boxes. When the Consolidated Freight Classification was amended to authorize the use of the glued lap joint, real progress began on glued lap containers.

The first commercially available machine to make this type box was a combination folder and gluer. The box blank is fed from a hopper, through the machine by a lightweight tubular shuttle. The blank is advanced from the hopper to the first folding stage, where the two panels are folded up to 90° by means of a pair of spirals rotating about a horizontal axis. The second stage of folding is completed by a second set of spirals, rotating about a vertical axis. These bring the fold to a full 180°, and the blank is squared at the same time by two centering plates.

The adhesive is applied to the glue lap as it leaves the hopper by a separately driven applicator wheel. The folded and glued blank then passes through a delivery conveyor which acts as a compression section to allow the adhesive to set.

The second machine was a semiautomatic version of the machine described above. It is arranged for the operator to partially fold the blank on the pile ahead of the machine and insert it into the machine. A similar applicator wheel applies adhesive to the lap, and one panel is forced down to complete the fold. A similar compression section delivers the box blanks folded and glued.

Sufficient experience with glued lap boxes has now been obtained to lead many people to think that the glued lap joint will soon take its place with the well-known stitched and taped joints in the manufacture of corrugated shipping containers.

The Development of Adhesions for the "Glued" Lap-Joint on Fiber Containers, F. R. DiFranco

In the development of an adhesive or adhesives for a specific task, in this case the manufacture of glued lap-joints on fiber containers, the questions first put to any development group are: (1) What are we required to bond? (2) How are we expected to make this bond, i.e., on what equipment and under what conditions of adhesive applications, compression of the bond, and handling after the bond is initially made? (3) What is expected of the bond other than holding the material involved together? These questions are considered.

Adhesives for Glued Lap-Joint Boxes, C. Jacobs

The subject of corrugated containers made with glued manufacturer's joints, as compared with those made with tape or stitches, has been discussed already, as have the topics concerning types of equipment used to make these boxes and the development of an adequate adhesive. The purpose of this paper is to touch briefly upon the remaining issues—production problems encountered in the manufacture of glued lap corrugated boxes.

Glued Lap-Joints on Fiber Containers, Alfred W. Hoffman

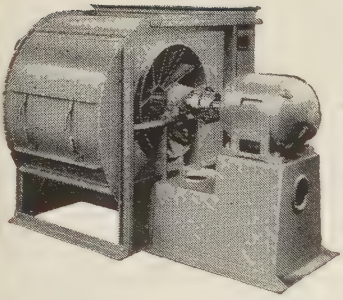
The requirements pertaining to glued lap-joints on corrugated and solid fiber boxes, set up by the Consolidated Classification Committee, are reviewed and the various forms of such joints on corrugated containers are briefly described. An analysis of the merits of glued lap-joints in comparison with those of taped and stitched joints is presented from the standpoint of price, performance as measured by laboratory tests, and other inherent features. These data involving a comparison among the joints are summarized along with comments as to practical validity of the tests.

Fundamentals of Regression and Correlation, Geoffrey Beall

The logic of regression is presented. The least squares solution is presented as an applicable technique. The existence of the two regressions and the danger of using one inversely are stressed. The character of the correlation coefficient, a dimensionless number that measures interdependence, is contrasted with that of the regression. The danger of confusing correlation with causality is treated. Finally, the dangers inherent in calculating a correlation are contrasted with the safeness of a regression.

Uneven Corrosion in Alkaline Pulping Digesters—A Major Cause and Possible Cures, F. W. Flynn, F. B. Snyder, and F. H. Richter

Several AISI type 405 alloy lined digesters installed in 1948 experienced severe corrosion shortly after going into service. Corrosion was not general throughout the digesters. Some areas were heavily attacked and other areas were uncorroded and were covered with film and scale. Study and experimentation in connection with this corrosion problem indicated that the corrosion results from a boiling action that takes place on the metal surface when small quantities of liquor contact the hot digester shell. This boiling action is similar to that occurring when small quan-



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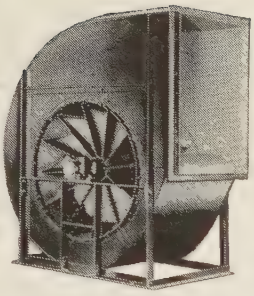

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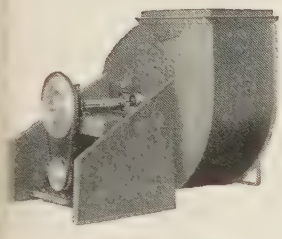

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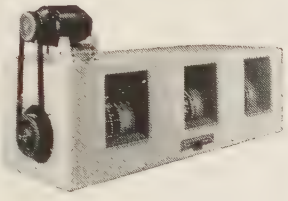

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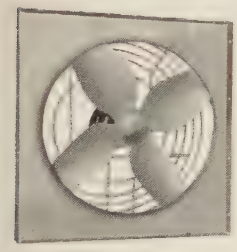

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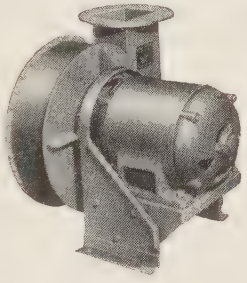

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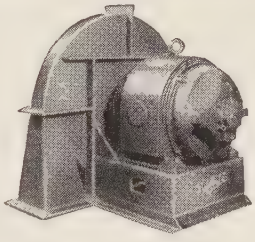

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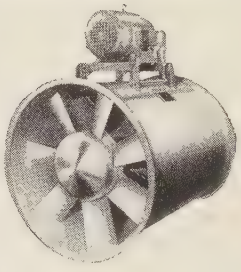

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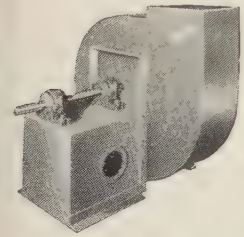

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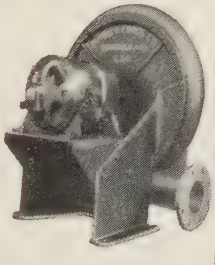

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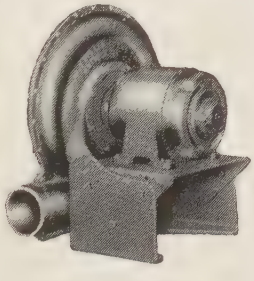

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For low to medium pressures and volumes in draft, cleaning, line boosting.

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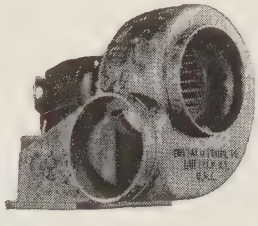

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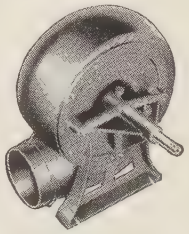

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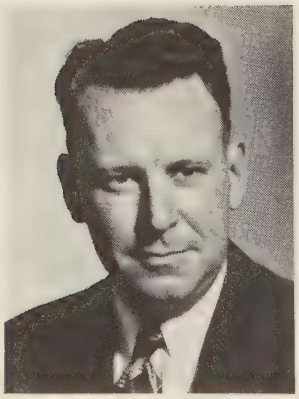
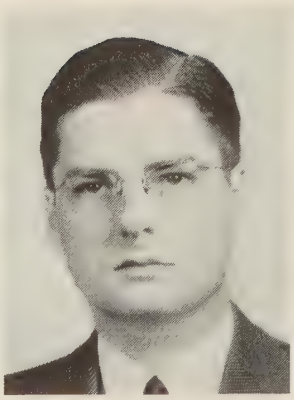


R. S. Thieme, Soundview Pulp Co.; Chairman, Pulp Testing Committee



J. P. Casey, A. E. Staley Mfg. Co.; Chairman, Nonfibrous Materials Testing Committee

tities of water were dropped on a hot plate. The type 405 alloy is corroded where this boiling action takes place, and is uncorroded and covered with film and scale where this action is absent.

The digester shell, following a blow, remains approximately at the cooking temperature. In refilling, heat is extracted quickly from surfaces completely submerged in liquor. When uncooled surfaces are contacted with small quantities of liquor such as result from splashing or foaming, hot plate boiling and corrosion result.

Splashing during refilling is a major source of hot plate boiling, and the method of refilling determines largely the areas which will be splashed and corroded.

Corrosion in type 405 alloy lined digesters was arrested by preventing the hot plate boiling action. Two different methods for doing this have been successfully applied. One involves the use of a specially designed metallic digester liner, the other involves admission of the filling liquor at the bottom of the digester rather than at the top.

Hot plate boiling appears to be an important factor in causing uneven corrosion in carbon steel digesters as indicated by study of corrosion and scale patterns, and methods of refilling. The methods used in arresting corrosion in type 405 alloy lined digesters should be beneficial in reducing uneven corrosion in carbon steel digesters.

Some Observations on the Causes and Prevention of Kraft Digester Corrosion, Edward W. Hopper

Carbon steel kraft digesters generally gave good service life up to 1934–35. Since that time, undetermined changes have been made which cut the life to as little as one to two years. This shortened life may be due to one or more factors or changes in the digester proper or in the pulping operation.

This paper has outlined variables in the steel, the liquor, and the circulation which may influence corrosive or erosive attack. Results of chemical, spectroscopic, and microscopic examination of digester steel samples are included. A method used in increasing the life of seriously thinned digesters is described.

There apparently is no clean-cut cure-all for the excessive corrosive attack. There were probably other contributing factors and better methods for controlling attack. It is hoped that this paper may tend to emphasize the scope and ramifications of this expensive problem and stimulate thought along all lines that may contribute to decreasing the rate of corrosive and erosive attack.

Experiences with Field Applied Inconel Digester Linings, S. J. Baisch

An experimental attempt was made to solve the digester corrosion problem by field lining a digester with 1/8-in. thick Inconel strip. The experiment was later expanded to include two digesters of the tumbling type. This report tells of the experiences of the one vessel having 2 1/2 yr. of lining service and the other a little over 1 yr.

The results show that excessive cracking has occurred in the welds adjacent to the Inconel strip and that a scale formation is taking place between the lining and the carbon steel backing of the digester.

Believing that excessive temperature differential was occurring between liner and steel, a method for measuring temperature behind liner, in carbon steel backing and outside of carbon steel shell with the aid of pencil-type thermocouples, is given.

In general, the alloy Inconel has shown excellent corrosive resistance to alkaline pulping liquors, but further consideration must be given to a welding procedure to seal the liner to the carbon steel shell of the digester.

Pressure Vessel Steel Specifications and Related Processes, H. F. Peters

The terms "killed," "semikilled," and "rimmed" refer to types of steel produced by various deoxidation practices. The killed and semikilled steels have a higher silicon content, but less segregation in the center of the ingot than a rimming type steel, the latter type steel being characterized by a rim of relatively pure metal. In gages under 1 in., rimmed steels are suitable for automatic welding but due to inherently greater segregation in gages of 1 in. and over, the weldability of these steels using an automatic process is not as good as either killed or semikilled steels. For those applications, such a digesters, where the rim zone is considered important from a corrosion viewpoint, it is possible to produce a steel with a sound rim zone with increased weldability by special deoxidation techniques. Segregation is an inherent phenomenon in the solidification of steel, the pattern and magnitude of the segregation varying with the element under consideration and generally increasing for all segregating elements as the size of the ingot is increased. The importance of the knowledge of this phenomenon to the end user is to add to his understanding of the difficulty of specifying a steel to a very narrow chemical specification and, also, that chemical analyses to meet specifications are taken from samples out of the ladle and so give the average chemical analysis and not the maximum and minimum precentages existing in the finished plates.

Firebox quality steel is, as the name implies, a steel that has been given extra care in making and testing to insure good quality within a certain specification, i.e., A-285 Firebox, Grade A; A-201 Firebox, Grade A; etc. Firebox quality steels do not have high-temperature properties in the same sense as do alloy steels.

Flange quality steels are made to the same specification as are firebox quality steels, but they do not have to meet as rigid chemical and physical requirements. Steels of flanging quality are designed to meet the rigors of fabrication, but not long service under difficult conditions, such as externally fired pressure vessels subjected to fluctuating thermal and mechanical stresses.

In the review of old boiler steel specifications and their comparison with the present-day pressure vessel steel specifications, the only discrepancy worthy of note that might have possible effects on the digester corrosion problem is the question of silicon content. Before the development of the automatic welding processes, digesters were fabricated by either riveting or forge welding. Steels for the latter two processes were of a true rimming type; however, it was found that rimmed steels in gages of 1 in. or better were difficult to fabricate by the automatic welding process. The steel companies, in an effort to keep abreast of developments in the field of fabrication, have been supplying killed and semikilled steels whenever it was specified that automatic welding was the method of fabrication. Even when end use was not specified for steel plates made to A-285 specification in gages over 1 1/2 in. the steel companies supplied a silicon killed steel. This practice is not in violation of the usual rimmed steel specification, namely, A-70 (which was replaced with A-285) because this specification does not stipulate a deoxidation practice.

Another possible variation in the steels used in old digesters and the present-day steels is the fact that large plates of high-tensile, silicon-killed steels are being used to take advantage of fabrication economics in the building of large digesters. Such steels will have a higher silicon, carbon, and manganese content than the old rimming steels.

Hastelloy F—A New Corrosion-Resistant Alloy for Lined Digesters, M. O. Scheill

A new corrosion-resistant alloy manufactured by the Haynes Stellite Co. and based on the nickel-chromium-molybdenum-iron system is designated as Hastelloy alloy F with the following balanced chemical composition:

Hastelloy Alloy F

Carbon	0.08% max.
Manganese	1.00–2.00%
Phosphorus	0.040% max.

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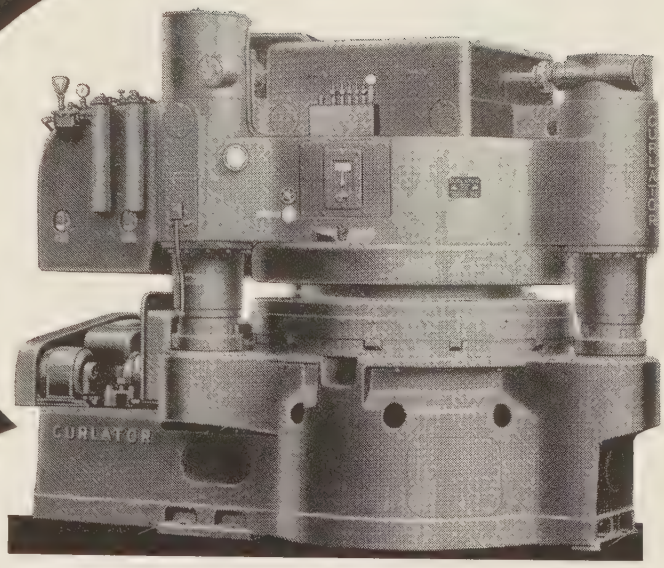

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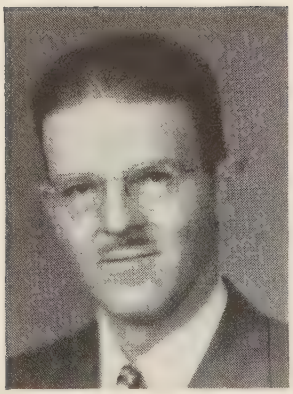

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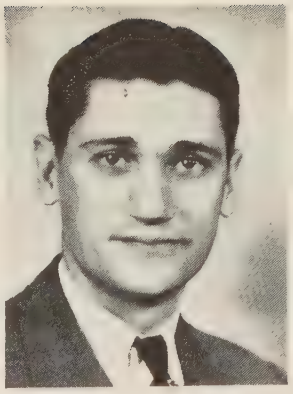

C. E. Brandon, The Howard Paper Mills, Inc.; Chairman, Microscopy Committee

Sulphur	0.030% max.
Silicon	1.00 max.
Chromium	21–23%
Nickel	44–47%
Molybdenum	5.5–7.5%
Columbium + Tantalum	1.75–2.5%
Tungsten	1.00 max.
Cobalt	2.50 max.
Copper	0.15 max.
Iron	Balance

The alloy possesses good resistance to pitting, stress corrosion cracking, and crevice type corrosion. It has shown especially interesting possibilities as a lining material for sulphite digesters and numerous tests described in the article and conducted by the A. O. Smith Corp. have demonstrated that the fabricating properties of the alloy are satisfactory for the construction of lined vessels.

The outstanding application to date of this new alloy has been in lined digesters used for preparing sulphite pulp.

Field exposure tests under severe service conditions in stationary alkaline digesters have indicated a corrosion rate in the vapor of about 0.003 i.p.y. as compared with about 0.009 i.p.y. for Inconel and up to 0.022 i.p.y. for type 347 (18–8 Cb) stainless steel.

In sulphite service where alloy T316 (18-8 Mo) was pitting in the vapor condition, Hastelloy alloy F is now being used with good success.

With the limited experience on this alloy it would appear that Hastelloy alloy F offers a remarkable combination of properties for both acid and alkaline service.

Tests in alkaline conditions have run 2 yr. and over 3 yr. in acid service. While this time is short to evaluate a new alloy for all the service conditions the indications are promising for success.

The article describes several metallurgical, corrosion, welding, and simulated thermal shock and fatigue tests used to evaluate Hastelloy alloy F as an applied lining for digester service.

The alloy has been used to line the top heads of two sulphite digesters, one 15 ft. diam. and one 19 ft. diam.

Methods for the Determination of Cellulose Chain-Length Distribution, Geoffrey Broughton

A review is made of methods available for determination of molecular weight distribution in cellulose from the standpoint of selecting a suitable method for routine determinations.

Variable Shear Viscometers for Cellulose Intrinsic Viscosity Determination, F. H. Wetzel, J. H. Elliott, and A. F. Martin

Viscosities of a number of samples of cellulose have been measured in 0.5 *M* cupriethylenediamine using Ubbelohde, modified Wagner-Russell, and Brookfield viscometers. From these data, intrinsic viscosities ($[\eta]$) were calculated using the one-point method proposed by Martin (*Tappi* 34: 363 (1951)) and compared with values obtained by the multipoint procedure at the normally encountered shear rates and also with values obtained at zero shear rate.

For solutions having $[\eta]\ C = 3.0 + 0.5$, where C is concentration in grams per 100 ml., it was found that for samples whose $[\eta] = 10$ or lower, the solutions are Newtonian and hence the measured values are independent of the rate of shear. For samples having a higher $[\eta]$, the solutions are shear sensitive. In the range $[\eta] = 10$ to 16, $[\eta]$ may be obtained by the one-point method with moderate accuracy using shear rates in the range 50 to 250 sec.$^{-1}$. Samples having $[\eta] > 16$ show marked shear sensitivity, and viscosities should be obtained at as low a shear rate as feasible. Intrinsic viscosities, obtained from such data, will approach the theoretically sound value calculated from data at zero rate of shear.

It is recommended that viscosities be measured at a maximum shear rate of 50 sec.$^{-1}$. Reliable intrinsic viscosities are obtained from these observed viscosities by the one-point method. A simple rapid rotational viscometer is suggested for control use and a capillary instrument for referee use.

Fundamental Dimensions of Appearance Quantities, R. S. Hunter

To understand the limitations of the various measurement scales for color, gloss, directional reflectance, turbidity, etc., one must be familiar with the assumptions, distinctions, and experimental data which underlie them. In real life, objects and materials appear in settings of infinite variety. The ability which the human eye develops to identify the different elements of its ever changing visual field is remarkable. One finds this out when he starts to construct optical scales to duplicate by physical measurements some of the distinctions which the eye makes. The variety of real life situations has to be limited by standardizing the settings and limiting the factors measured to only the major ones. Because of these simplifications and limitations, the measurement methods for color, gloss, reflectance, turbidity, etc., are limited in application to comparisons of otherwise similar specimens. Complete specifications for optical appearances are not feasible.

The Deculator on a Kraft Paper Machine, A. W. Duskin and W. B. Jenkins

The Deculator, a process for deaerating dilute paper stock before the stock enters the headbox is described, operation problems are discussed, and results obtained on the Crossett Paper Mills machine are enumerated. This paper covers only the operation and results obtained on the first kraft paper machine on which a Deculator was installed.

The most important results obtained due to the Deculator installation were: elimination of wire pit and headbox foam; the average monthly lost time due to wet end breaks was decreased approximately 3 hr., and for drier and dry end breaks 6 hr.; over-all machine efficiency showed an average monthly increase of 2.97%; basis weight variations in the machine direction were decreased; sheet formation and smoothness improved; drying efficiency was improved showing an average decrease of approximately 1000 lb. of steam per ton; no noticeable change was noted in physical properties of the sheet and maintenance costs have been low.

Automatic Transfer Equipment, Lloyd Hornbostel

Speed of open type paper machines is limited by safety of operation at draw between suction couch and first press felt, with maximum safe speed being a function of basis weight. Conventional pickup felt operation eliminates this limitation but is deficient in that excessive water is carried to the press section, sheet strength is damaged, some fiber is left behind on the fourdrinier wire, and new clothing sometimes necessitates reduced machine speeds. Suction pickup arrangement was installed by Beloit Iron Works experimentally in 1931 and 1932, with recently improved types operating successfully at speeds in excess of 1900 f.p.m. The value of automatic transfer equipment in news mills, for example, is indicated as: making possible increases in production of existing machines approximating 35%, providing paper with better printing characteristics due to increased groundwood content, reducing breaks on machines by at least 75%, reducing chemical pulp content of sheet from 20 to 10%, helping in forestry conservation programs by reason of reduced shrinkage of groundwood over chemical pulp in furnish.

The Liquid Ring Compressor—Some Thermodynamic Characteristics, Harold E. Adams

The liquid ring vacuum pump widely used in the papermaking industry, pumps and compresses gases by building up kinetic energy in a spinning ring of liquid confined within an elliptical casing. It is so different from other types of conventional com-

Knives are everlastingly locked in BOLTON Wedgeless Plugs

The principle of the keystone arch, the device in architectural construction by which individual tapering or wedge-shaped pieces bind together a structure, is employed in the design of the **Bolton Wedgeless Plug** — in reverse, but with identical results.

BOLTON knives with dovetailed bottoms are driven endwise into precisely machined, dovetailed slots and then locked into position with **Bolton Dovetailed Woods**, thus assuring maximum holding power the entire length of the plug.

The woods cannot be forced out in motion and, like the keystone arch, **actually become tighter in use.** Any variety of cutting knives may be inserted in the slots of **Bolton Wedgeless Plugs.**

The plug body is of cast steel into which a hammered forged steel shaft is pressed with 60-ton hydraulic pressure.

With this plug, as standard equipment, we also supply a welded stainless steel end plate on the large end, as well as stainless steel end plate rings on both ends which come to the top of the woods and are designed to prevent washing of the woods and plug body at these points.

The result is a wedgeless plug of outstanding durability with the assurance of long, uninterrupted service. There is no substitute for a **Bolton Wedgeless Plug** supplied with:

1. **Cast Steel Body.**
2. **Stainless Steel Jacket on Cast Steel Body.**
3. **Stainless Steel Jacket mounted on your old plug.**

John W. BOLTON & Sons, Inc.

Lawrence, Massachusetts, U.S.A.

The DRAPER Felt
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pressors that its full characteristics are frequently overlooked because of thinking of it in conventional terms.

The pump is a veritable thermodynamic laboratory because of the intimate reactions occurring between the liquid ring and the gas or vapor pumped. Near isothermal compression can be achieved and when handling saturated mixtures, the machine acts as a combined condenser and large purge pump.

Because of its nonpositive nature, the water ring vacuum pump and compressor is rated by an actual test under a standard set of thermodynamic conditions, using dry air as the calibrating medium.

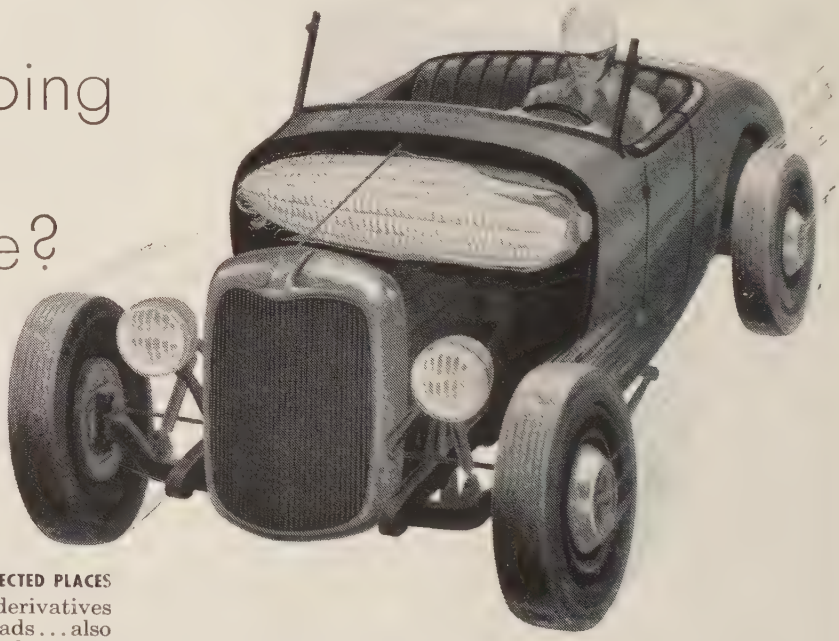
It is subject to wider variations than positive type pumps when operating conditions differ much from standard. This basis of rating should be kept in mind when applying the pump. It is shown that the water ring vacuum pump has greater capacity for saturated air mixtures than its rated dry air performance.

It is also suggested that a more definite basis of measuring and stating vacuum pumping requirements is desirable over the present tendency to give paper machine requirements in terms of water ring pump ratings. The latter are so subject to modification under the job conditions that definite specification in their terms is impractical.

In the application of these pumps to paper machines, the condition is usually met where a saturated air mixture has to be removed at a temperature higher than the water seal supply for the vacuum pump. A typical example cited in the paper involves suction on a couch roll with entering saturated mixture of 110°F. and with water seal at 80°F. In this case, full calculations are given for the selection of a water ring pump and it is shown that under these conditions, a 1000 c.f.m. requirement can be handled by a water ring pump rated at only 812 c.f.m. A factor of 125% should be applied to the standard data to obtain actual capacity on this job.

Other typical paper machine operating conditions are listed with appropriate factors for selecting properly sized pumps. The importance to the papermaker of such items as seal water temperature and quantity is brought out because material improvement can be affected by a thorough understanding and application of the thermodynamic characteristics of water ring vacuum pumps.

what's **corn** doing hitting "70" down the pike?



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Under the hood of your car for instance... derivatives of corn were used in casting the cylinder heads... also in extracting (from its oxide, alumina) the aluminum used in the pistons and other essential parts. This is but one of the numerous examples of how continuous basic research in corn helps American industry... helps you.

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Picture of "VANCEOMETER" Absorbency Tester courtesy of Hillside Laboratory, Hillside, Illinois

Expanded Monel

Expands the Service Life

of filter sectors

Welder tacks expanded Monel backing mesh to frame of an experimental model pulp filter sector. Design finally chosen uses mechanical assembly. Some 400 have been installed in a large Canadian mill. They promise 400% longer service life than previous sectors using other metals.

Four years ago a large Ontario, Canada, paper mill started looking for better filter equipment service and greater economy.

Filters failed often and were costing too much to make and to repair.

Various combinations of metals in different fabricated forms were tried. And finally an assembly was developed which proved most economical . . . considering both first cost and length of service life.

The assembly . . . aluminum sector frame . . . and a backing mesh of .050 in. expanded Monel with ¼ in. x 1 in. diamonds. Backing and facing wire are attached with Monel strap and machine screws; no solder is used.

Why expanded Monel? Because expanded Monel has strength to withstand constant usage. It has corrosion resistance to withstand chemical attack.

Four hundred of these sectors have been installed. Some have been in service for over twenty months. No significant galvanic corrosion has occurred on the aluminum frames; all are still in excellent shape and promise *4 times more service life* than previously used metals.

Perhaps expanded Monel offers the answer to getting better service from equipment and more economical operations in your plant. Consult your Distributor of Inco Nickel Alloys for the latest information on their availability from warehouse and mill. Remember, too — it always helps to anticipate your requirements well in advance.

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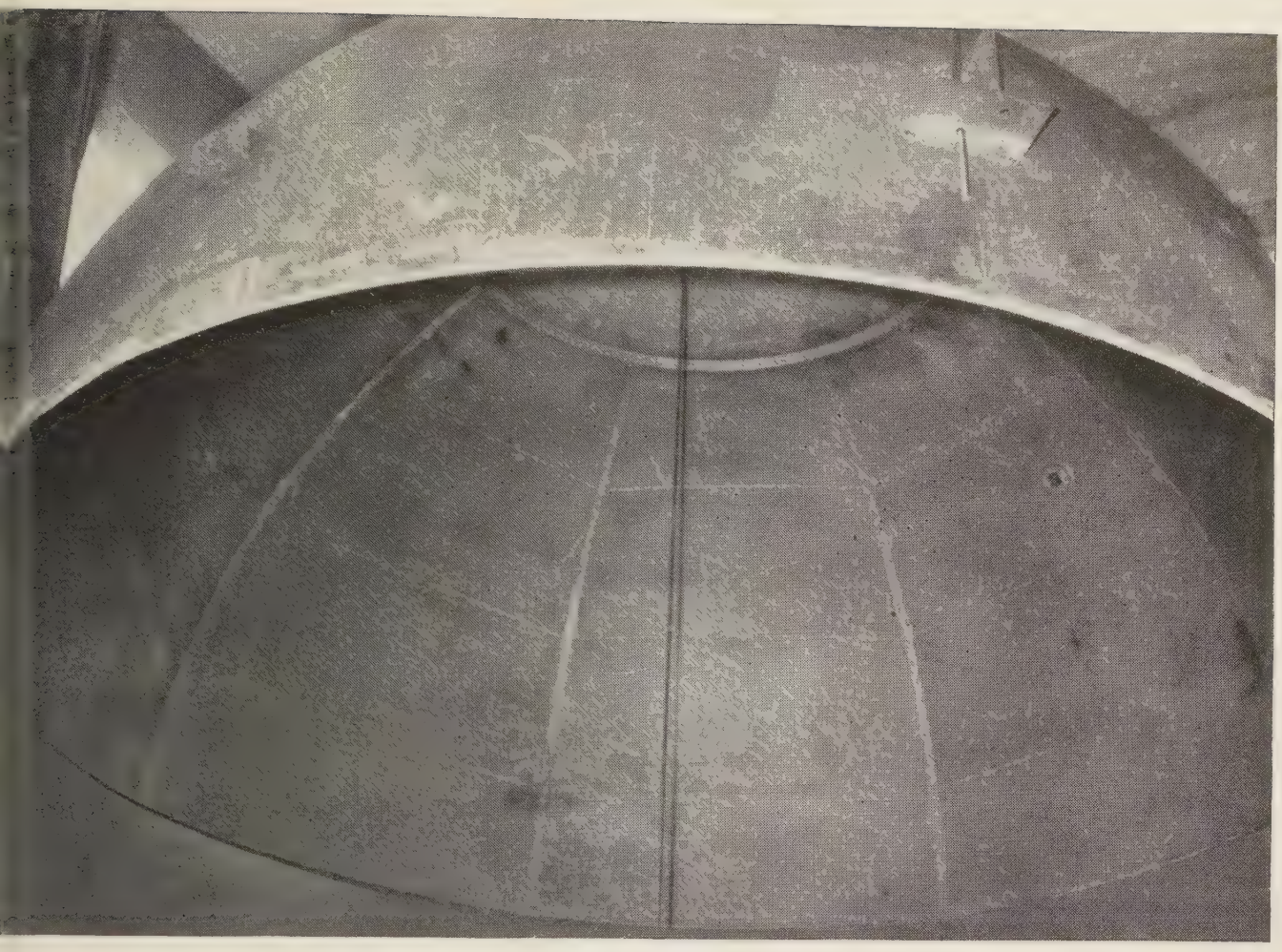
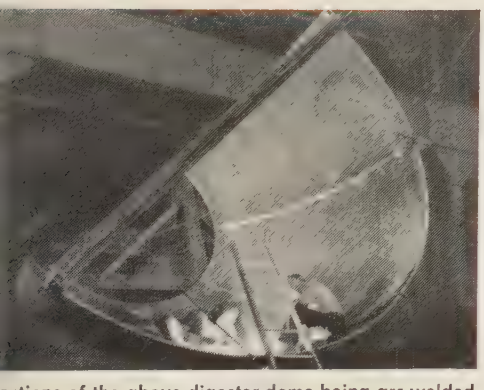


Dome section of world's largest sulphite digester, SMITHlined with Hastelloy alloy F.

Sulphite Digesters SMITHlined with Hastelloy* Alloy F Overcome Dome Pitting Problems



ections of the above digester dome being arc welded ogether in the A. O. Smith vessel shop.

igester sections being assembled prior to erection at he paper mill. Completed it will be 58 feet high, ith 19-foot inside diameter.

For many years, A. O. Smith research engineers have been working on the corrosion problems that beset digesters in the acid pulping phase of paper manufacture. Most alloys that are satisfactory when in contact with the liquor, suffer severe pitting from corrosive action of the vapor in the digester dome.

Extensive experience with the nickel-base alloy, Hastelloy alloy F, in laboratory programs and field exposure tests, suggested its use for sulphite digesters.

Three years of field service tests confirmed our belief that Hastelloy alloy F provides a long sought solution to the problem of vapor pitting.

The metallurgical characteristics of Hastelloy alloy F are *ideally suited for the SMITHlining process* of resistance Welding. (SMITHlining is the closely controlled resistance welding process of inseparably bonding alloy sheets to carbon steel digester walls.) A. O. Smith also *developed special coated electrodes* for metallic arc welding to assure a completely uniform Hastelloy alloy F lining.

This is just one example of our efforts to help the Paper Industry solve its digester problems. The data accumulated from our comprehensive laboratory and field testing programs is available to you. Consult A. O. Smith on your digester problems.

*Registered Trade Name of Haynes Stellite Company, a Division of Union Carbide & Carbon Corp.

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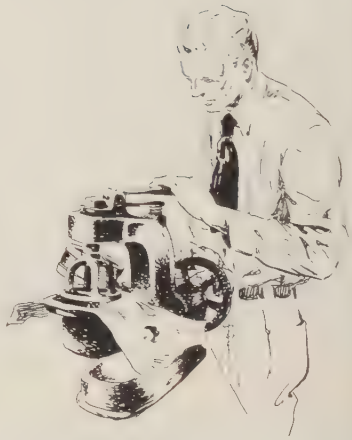
APPLETON - - - - - - - another in a series of scenes... areas where Appleton Wires serve the paper industry.

HESITATE here for a moment on Memorial Drive Bridge and glançe downstream. This is Appleton, Wisconsin...a busy town...a beautiful town ...a pleasant blending of culture and hospitality, higher education, industry, science and agriculture. We are proud of our home town.

Right here at home, in the heart of the Fox River Valley, you'll also find the paper industry. All of these neighborhood mills know, from long experience, that *Appleton Wires are Good Wires!*



APPLETON WIRE WORKS, INC., APPLETON, WISCONSIN

"There's no other color like it in town..."

When you can point up the DISTINCTIVENESS of the colored wrapping paper you've sold to a store, you can be sure that you have given the merchant a strong sales-promotion tool.

And you can bet that you've given him the kind of help that results in *new* orders and *re*-orders for you!

A *distinctively* colored wrapping paper is a *walking advertisement* that his customers will carry on packages all around town. Being "tailor-made" for the merchant, it will remind people not just of shopping, but of shopping at HIS store.

So that you can give him *exactly* the color he wants, Du Pont offers hundreds of shades of colors that you can sell for paper, boxes, cartons and gummed tape. And Du Pont will give you technical service that will help you select a distinctive dye. For more information, write E. I. du Pont de Nemours & Co. (Inc.), Dyes and Chemicals Division, Wilmington 98, Delaware.

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Du Pont Dyes

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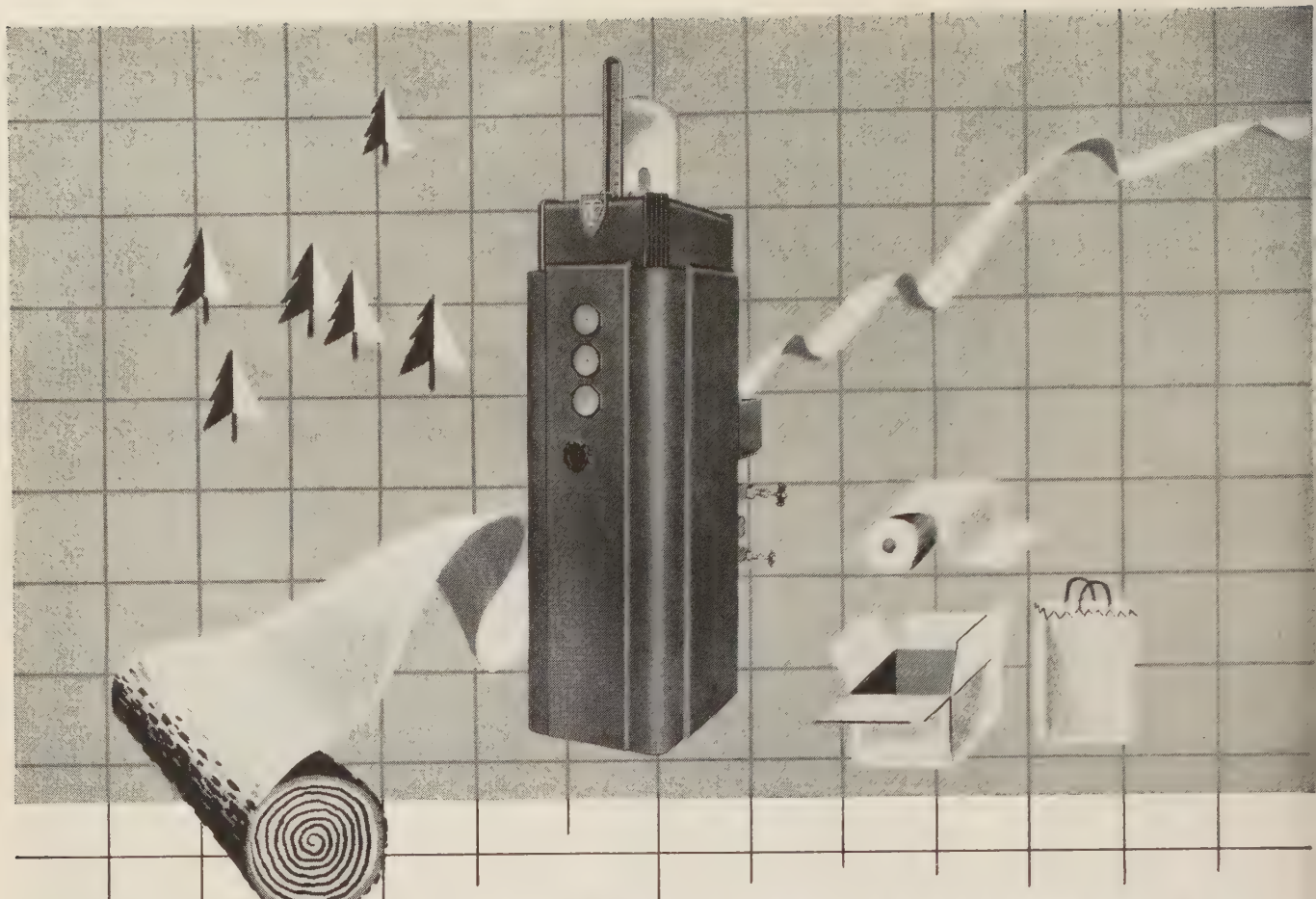
BETTER THINGS FOR BETTER LIVING ... *THROUGH CHEMISTRY*



production increased up to 15 tons per day...

. . . with W & T chlorination equipment

A Southern mill had been having trouble with paper breaks attributable to the presence of slime in their white water. Despite continued efforts to control them slime breaks were running 60 to 80 per week, resulting in a time loss of 10 to 14 hours per week, and an average production loss of 15 tons per day! It was then that the W&T man was called in. Where and how to apply the proper treatment was determined, the costly methods were discontinued, and W&T chlorination was installed.

During the first 3 days of chlorination the mill recorded only 1 slime break and 2 minutes of lost time.

During the next 3 days there were 4 breaks and 17 minutes of lost time.

During the next 25 days there were no breaks attributable to slime!

. . . Within a week there were no production losses caused by slime! Performance such as that is typical of what your W&T representative can do for you.

If you have a production problem attributable to impure water, it would pay you to write or call him now.

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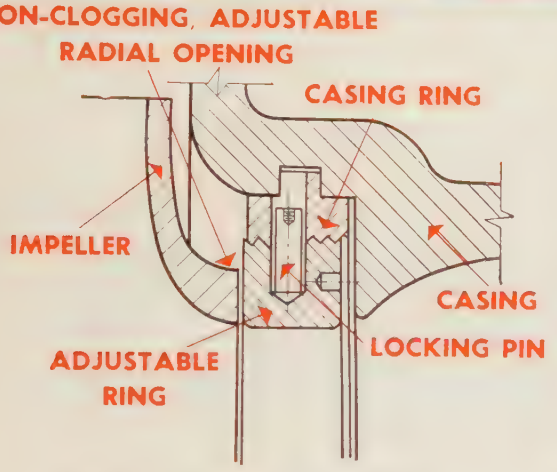
- *Adjustable clearance keeps efficiency high*
- *Radial opening eliminates damage from jamming*

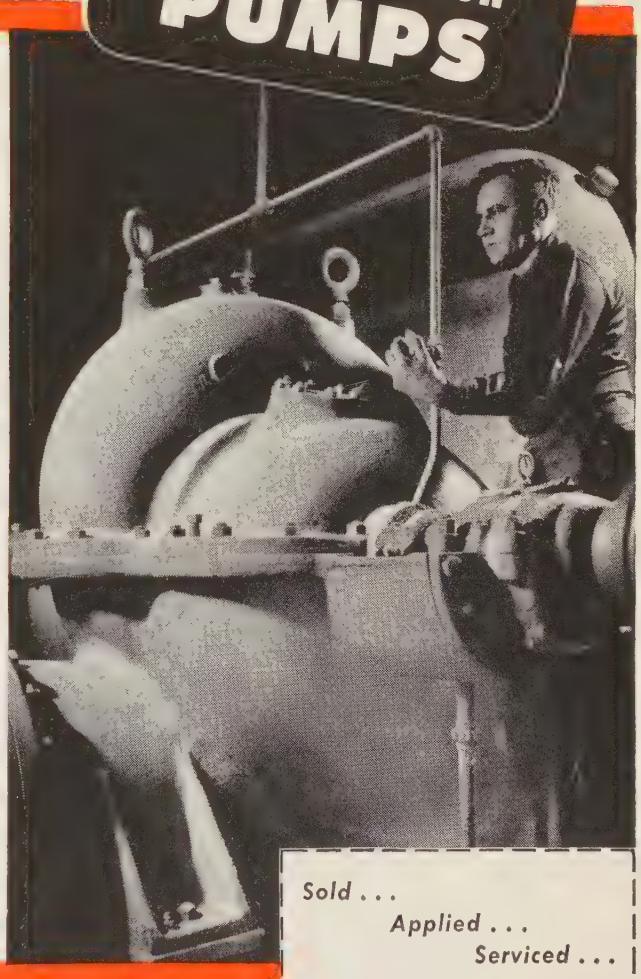
ALLIS-CHALMERS Double Suction PUMPS



Here's How It Works

Clearance between the wearing ring and the impeller can be adjusted by simply removing the locking pin, turning the threaded inner ring until the correct clearance is established and resetting the locking pin. In addition to keeping efficiency high, small clearances also tend to exclude solid materials and reduce clogging problems.

With ordinary wearing rings, solid material between ring and impeller may deflect the shaft or cause the impeller to seize. With Allis-Chalmers wearing rings with radial clearance, solid materials between rings simply increase the load on the thrust bearing slightly and wear themselves free.



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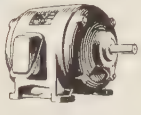
by Allis-Chalmers Authorized Distributors, Certified Service Shops and Sales Offices throughout the country.



MOTORS — ½ to 25,000 hp and up. All types.

CONTROL — Manual, magnetic and combination starters; push button stations and components for complete control systems.

TEXROPE V-belts in all sizes and sections, standard and *Vari-Pitch* sheaves, speed changers.

YOU CAN GET HELP on all your stock handling problems from an Allis-Chalmers pump engineer. And Allis-Chalmers can supply the complete pumping unit — pump, motor, drive and control — all of coordinated design and manufacture . . . assembled and ready to install.

For more information on Allis-Chalmers pumps for paper mills, call your nearby Allis-Chalmers Authorized Distributor or representative or write Allis-Chalmers, Milwaukee 1, Wisconsin. Ask for centrifugal pump Bulletins 08B6146, 52B7112 and 52B7839.

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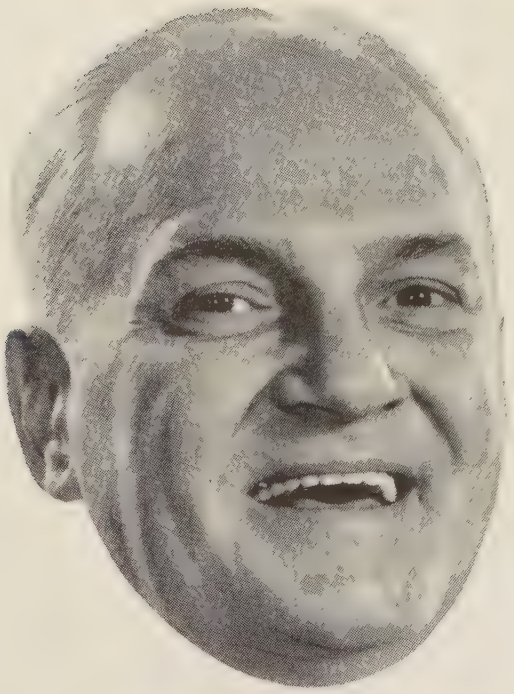

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GLIDDEN PROSIZE

No matter what your present sizing practice may be, it will pay you well to have a representative of the Glidden Technical Service demonstrate all the advantages you can gain from using Prosize in your mill. After changing from conventional rosin size to Prosize, users have reported that . . .

- Prosize Process is 200 to 300% more efficient.
- Prosize Process produces a better, more stable size which gives paper uniform resistance to liquids of various types, such as ink, water, meat juices, etc.
- Prosize Process permits duplication of results from run to run on grades never before made because of sizing difficulties.
- Prosize Process minimizes seasonal variations—is highly effective on stocks heated by long beating or hard jordaning.
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- Prosize Process requires from 35 to 65% less rosin size and from 15 to 30% less alum, making it generally *less expensive* to use.

Prominent mills with a combined production of thousands of tons of paper a day have proved this patented Glidden Prosize Process, utilizing Glidden Alpha* Protein in combination with rosin size and boric acid, to be a superior means of sizing.

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for DIAMOND Automatic Cleaning OF CHEMICAL RECOVERY BOILERS

Diamond Automatic Soot Blowers have been sold for the cleaning of chemical recovery boilers in the following plants. This list covers all but three or four of the black liquor jobs placed in the United States and Canada in recent years. The reason for this overwhelming preference? You obtain correct recovery boiler cleaning and high boiler availability at minimum cost by using Diamond Automatic Soot Blowers.

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Calcasieu Paper Company
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Canada Paper Company
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Champion Paper & Fibre Co. *(2 Plants)*
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International Paper Corp. Southern Kraft Division *(7 Plants)*
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Macon Kraft Company
Marathon Paper Company
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Oxford Paper Company
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There is a DIAMOND SOOT BLOWER for Every Boiler Cleaning Requirement

Turbulent Suspension Burning as Applied to Steam Generating Units for Paper Mills

OTTO DE LORENZI

During the semi-annual meeting of the American Society of Mechanical Engineers at San Francisco in June, 1949, preliminary development work and test results on single-stage furnaces, burning wet wood, were discussed. The design, employing the principle of suspension burning, has now been refined. At present several units are in various stages of construction, while an additional one has been in continuous service for a period of over 20 months. Considerable operating data, covering a wide range in capacity, while burning wet wood-room refuse, fuel oil, and high as well as low-volatile coals are now available. The effectiveness of this method for firing solid fuels is reflected in the performance obtainable at apparent heat liberation rates which exceed those normally accepted as standard. A motion picture of actual furnace operating conditions clearly shows the effective flash drying and devolatilization obtained through use of suspension burning in a highly turbulent furnace operation.

PULP and paper mills in the United States have been most cooperative by their participation in and contributions to the many significant developments for reducing fuel costs, through process modifications and the efficient utilization of by-products. A major factor in three of these developments has been the use of flash-drying principles to: increase capacity and efficiency of lime kilns; salvage chemicals used in the pulpmaking process and also produce simultaneously a substantial amount of by-product steam for plant use; and improve efficiency of steam generation when burning wet bark and wood-room refuse, either separately or in combination with coal, oil, or gas. For this paper, however, the discussions will be confined to recent furnace designs in which primary fuels are wet wood and other similar types of cellulose refuse.

Flash drying may be briefly described as a process in which wet material is dispersed in a stream of heated gas, under suitable conditions of particle size and temperature differential, so that a major portion of the moisture is flashed into vapor and carried off by the gas stream.

A paper (*1*) presented during the semi-annual meeting (1949) of the ASME in San Francisco stated: "Use of the two-stage furnace, comprising a Dutch-oven and a secondary combustion chamber, has been generally accepted as a standard for 'hog fuel' and other kinds of wet-wood refuse. Recently, however, large scale experimental installations of the single-stage furnace using both underfeed and spreader firing have been operated successfully. As a result of these developments, there are now available, for many types of installations, simplified combustion systems, having high inherent capacity, to which automatic controls may be easily applied." Since the foregoing was written however, spreader applications have found almost universal favor, and underfeed designs have been entirely discarded.

For a conventional spreader-stoker installation the distributors are located in the front wall at an elevation of from 3 to 4 ft. above grate level. Flight of fuel from distributor to grate is quickly completed over a relatively short and flat trajectory. Some of the smaller particles are carried upward by the gas stream and thus never reach the grate. The major portion of the fuel, however, has hardly started through drying and devolatilization stages before it reaches the fuel bed. With this arrangement only a very limited amount of moisture is flashed into vapor, and thus a greater part of drying and practically all of the combustion process actually takes place after the fuel comes to rest on the grate. This characteristic of the conventional spreader installation makes it necessary to supply practically all air for combustion through the grate and thereby limits the amount which may be used overfire for producing furnace turbulence or for effecting flyash return. Furthermore, if there is any erratic or slug feeding, particularly with high moisture fuels, partial quenching of the bed will immediately follow these periods of heavy feed. During intervals between slugs the fuel bed will gradually brighten, as drying and devolatilization of the fresh charge progress. Operating results under these conditions are somewhat less favorable than where continuous controlled feed is used.

To take full advantage of flash-drying effect in a spreader installation, it is necessary to increase time for flight of fuel through the furnace atmosphere. This can be accomplished by locating the feeders at an elevation of from 12 to 20 ft. above rate level. Inasmuch as a major portion of the burning will now occur throughout the furnace cavity, it becomes necessary to rearrange distribution of air supply so that a much larger percentage is made available above the fuel bed. Nozzles for this increased overfire air supply are best located in the four furnace corners below the feeders. With this arrangement it is possible to use large fuel particles because they are spun around in flight by the high velocity streams and retained in the rising column of burning gas for a greater length of time before coming to rest at grate level. It is this increased time of flight, through the hottest furnace zone, which causes: moisture to be quickly flashed into vapor; partial or complete devolatilization of the fuel to take place; and residual combustible constituents to become ignited before reaching the grate. Slug feeding produces no noticeable changes at fuel-bed level, and consequently there are no adverse effects on operating results. This arrangement of feeders and overfire air has changed materially the operat-

OTTO DE LORENZI, Director of Education and Fuels Consultant, Combustion Engineering-Superheater, Inc., New York, N. Y.

ing characteristics of spreader stokers by producing real turbulent suspension burning.

Turbulent suspension burning may therefore be defined as the principle of showering relatively large particles of solid fuel downward, from some considerable height in a towerlike furnace, through relatively large

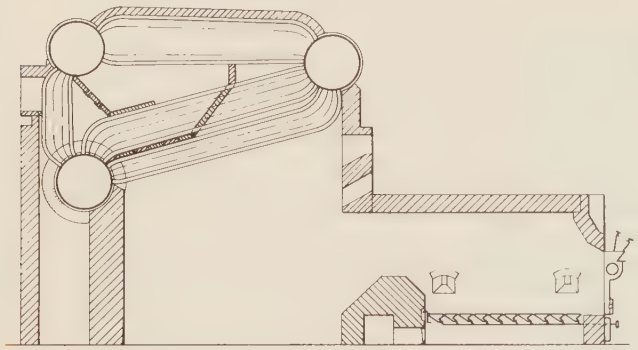

Fig. 1. Spreader stoker, applied to an existing two-stage furnace, for a plywood mill in British Columbia

quantities of highly turbulent gas and overfire air to effect: flash drying; partial or complete devolatilization; ignition of fuel constituents; and finally, uniform distribution of the residual fuel to the grate surface, in the lower furnace zone, where combustion is completed through reduced percentages of undergrate air.

Since 1949 the majority of new installations which use some form of wood or cellulose fiber refuse, as primary fuel, are spreader-stoker equipped. These steam-generating units employ single-stage furnaces without arches of any sort. Furnace walls are watercooled so as to minimize refractory exposure and thereby reduce sintering of ash and sand, with the result that in-service time between maintenance shutdowns is extended materially.

In some instances older two-stage furnaces, employing cone or pile burning, were changed over to spreader firing by installing suitable distributor units and grates in the original Dutch-ovens. Relatively thin and level fuel beds replaced the previously used piles, with a resultant speed-up in responsiveness to changes in steam demand, as well as increased burning capacity. This fact was clearly brought out in a paper (*2*) presented before the West Coast engineering section of TAPPI at Tacoma during February, 1951. "The maximum load that could be carried on no. 7 boiler on cone firing was between 65,000 and 70,000 lb. per hr. We have several load charts on spreader stoker operation that show an average of better than 75,000 lb. per hr. for the entire 24 hr. and a maximum of around 90,000 lb. per hr. for extended lengths of time."

One of the earliest successful installations for spreader- stoker burning of wet-wood refuse with a wide variation in size consist is in a British Columbia plywood mill. In this instance the original steam generating plant consisted of three bent-tube boilers, two rated at 440 hp. and one at 368 hp. all equipped with Dutch-oven furnaces for pile burning. The small unit was changed by installing a single spreader distributor. The original rate, 7 ft. 0 in. wide by 10 ft. 0 in. long was replaced with one 4 ft. 6 in. by 10 ft. 0 in. Sectional side elevation of the revised unit is shown in Fig. 1. The fuel is an indeterminate and continuously varying mixture of bark, slivers, chips, shavings, and sawdust from salt-water-driven fir and hemlock. Moisture content varies from 50 to 65%. The comparative continuous capacities are 17,500 lb. steam per hr. from the smaller spreader-equipped unit with a net grate area of 45 sq. ft., and 20,000 lb. steam per hr. for the larger cone burning unit with a net grate area of 120 sq. ft. The fuel is fed to all furnaces from a single conveyor. A 6-in. bar screen causes the excessive oversize pieces to by-pass all furnaces. These rejects, a relatively small percentage, are eventually hand-fired without further size reduction.

In another West Coast installation the conversion from pile burning to spreader firing is illustrated by Fig. 2. In this instance the grate is 17 ft. 6 in. wide by 9 ft. 2 in. long, having an effective area of 160.4 sq. ft. The secondary combustion chamber is partially watercooled and a live-bottom surge bin, using a chain-type feeder, is installed to assure control of fuel feed. For the actual fuel used, we again quote from the previously referred to paper (*2*): "The list of fuels includes dry planer shavings, green planer shavings, fir hog, sawdust, cedar hog, hemlock hog, bark and pulp bark plant and chipper refuse. This list varies in moisture from perhaps 8 to 70% and in size from sawdust to coarse cedar hog with a consistency similar to baled hay. Cedar bark is fibrous and tends to collect in bunches. It is not unusual for chunks to come in having a volume of as much as 50 cu. in. And 'shims' as they are called, which are very thin boards from 3 to 6 in. wide and a matter of feet in length are sometimes a real nuisance. The inability of the conveying and measuring equipment to properly handle the rougher types of fuel has been the most difficult problem to arise. Much time and expense have gone into solving this problem with only limited success. This difficulty is not peculiar to any special type of firing, but is present whenever a controlled system of distribution or measuring of hogged fuel is attempted. At the present time with such a variety of rough fuel being handled, the one solution that seems most adequate is to segregate the fuel and rehog the coarse particles."

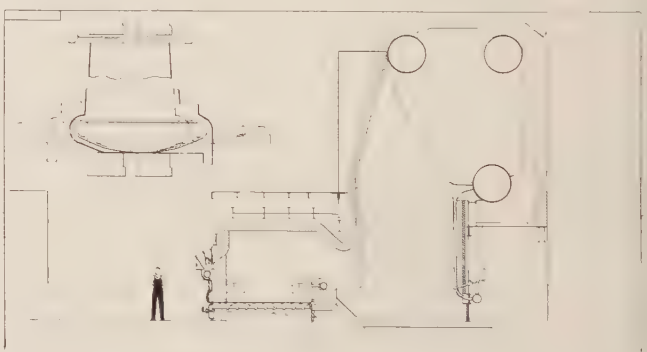

Fig. 2. Spreader stoker, applied to an existing two-stage furnace, for a Pacific Coast lumber mill

Experience gained from this unit (Fig. 2) has resulted in the installation of several other spreader-equipped steam generators using water-cooled single-stage fur-

naces similar to the one shown in Fig. 3. Heat-release rate of 24,500 B.t.u. per cu. ft. furnace volume and 720,000 B.t.u. per sq. ft. grate are used for guaranteed maximum continuous capacity. The fuel generally is sawmill refuse composed of sawdust, planer shavings, and hogged bark, along with other wood refuse. The percentage of these in the feed is dependent on the operation in which a particular plant is engaged. Some of the actual limits encountered are 10 to 70% sawdust, 30 to 60% planer shavings, and 0 to 50% hogged fuel. Where logs are salt waterborne, furnace wall deposits will usually result from salt and marine encrustations picked up during transit from forest to mill. With fresh waterborne logs these deposits are either of a minor nature or entirely absent.

Some time ago a southern paper mill installed a single-stage type unit designed, Fig. 4, for a maximum continuous capacity of 90,000 lb. steam per hr. with wood-room refuse and 150,000 lb. per hr. for either natural gas or a combination of natural gas and wood. An actual capacity of 115,000 lb. per hr. has been easily

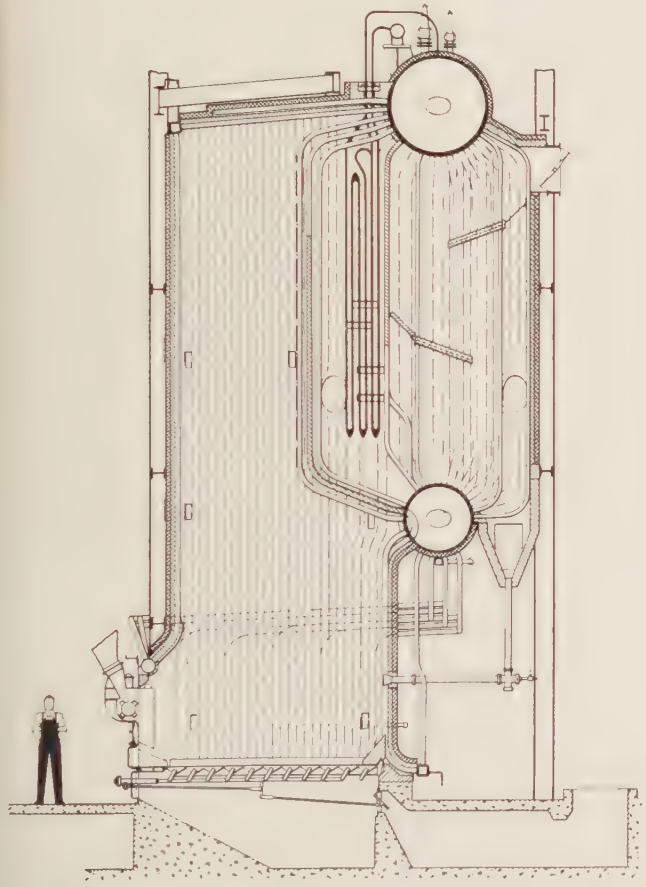

Fig. 3. A West Coast installation for burning wet-wood refuse from a lumber mill operation

maintained with wood refuse containing 45% moisture. Wood supply to the four spreader distributors is regulated through a live-bottom surge bin. Overfire-air jets, angled slightly downward through the rear wall, provide added furnace turbulence. Use of air at 350°F. is of considerable assistance in the successful operation of this unit at 115,000 lb. per hr. with a corresponding grate release rate of 880,000 B.t.u. per sq. ft. per hr.

The foregoing installations all use spreader distributors set in a conventional manner. Distribution is solely dependent on speed, and adjustment of this mechanism as influenced by size consist of the fuel used. Designs of this type are indicated for plants in which size of steam-generating units lie below 70,000 to 80,000 lb. steam per hr., or where it is necessary for economic

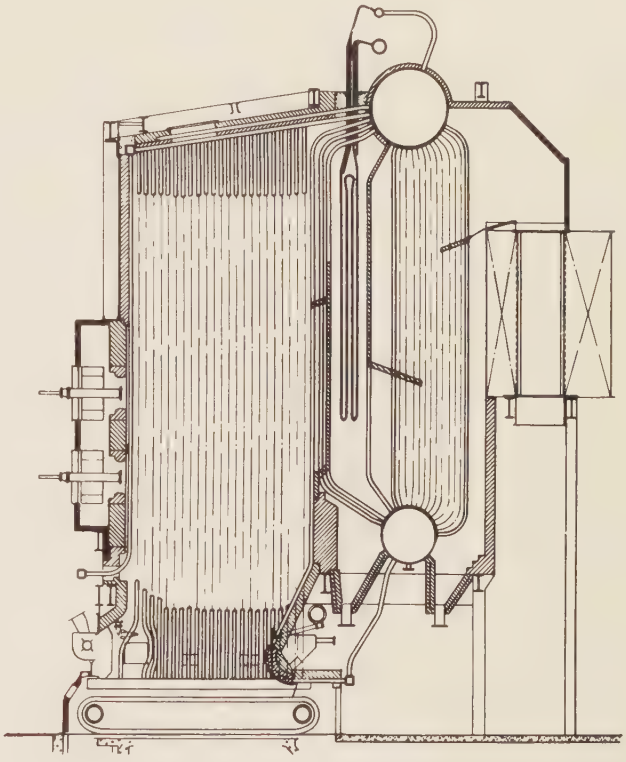

Fig. 4. A southern paper mill installation for burning wood-room refuse and natural gas

reasons to produce steam at low efficiency, or where the unit also serves as an incinerator for any overproduction of nonsalable refuse.

During the early part of 1946 an experimental steam-generating unit, Fig. 5 was placed in service for a southeastern naval stores plant. It included a single-stage furnace in which spreader distributors were raised from the conventional elevation of 3 or 4 ft. to a point approximately 19 ft. 0 in. above grate level. Provisions were made for supplying all or part of the air for combustion through tangentially directed nozzles located in the zone below distributor level and above the grate. This unit, is therefore, the first application of the principle of turbulent suspension burning as defined in the early part of this paper.

Fuel differs somewhat from ordinary wood refuse in that it is by-product to a process in which old pine stumps are first given a preliminary spraying with water to remove part of the sand and soil carried by the roots. After this rinse the stumps are passed through a series of high-speed chippers. The resulting chips then enter cookers where steam is used to remove practically all the resins and pitch. The spent-wood chips, devoid of the flashy ignition characteristics of pine, are then burned to produce steam for process requirements.

Design of this experimental unit was projected for a steam capacity of 70,000 lb. per hr. The furnace is 10 ft. 0 in. wide, and active grate area is 123 sq. ft. Fur-

nace height is 32 ft. 0 in. above grate. Side walls and rear wall are partially watercooled. Overfire-air nozzles are arranged for four alternately rotating tangential belts to provide the swirling and highly turbulent zone through which the fuel must travel on its flight to the grate. Air for combustion is actually obtained

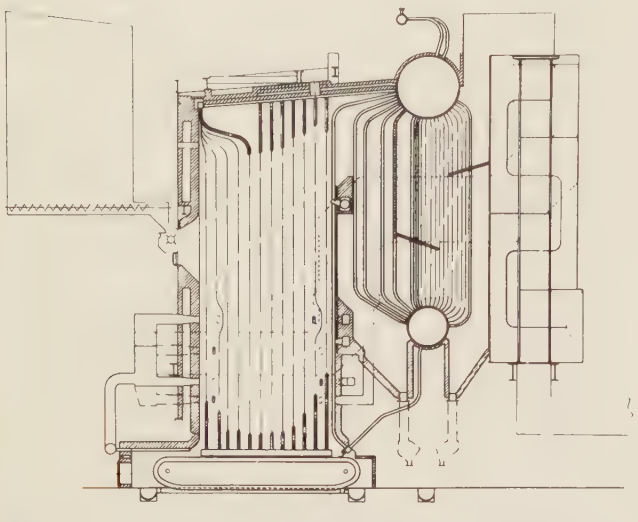

Fig. 5. A large-scale experimental unit, in a naval stores plant, for turbulent suspension burning of spent-wood chips

from three main sources: underfire, at room temperature, through stoker grate by furnace-draft induction; overfire from air heater, by forced-draft fan, to furnace nozzles; and leakage through distributor units and around stoker seals. A live-bottom bin is used to regulate flow of spent-wood chips to the distributors.

This experimental unit has now been in commercial service for over 6 yr. Some changes have been made to further improve operating characteristics. Design capacity was easily exceeded to the extent that 100,000 to 125,000 lb. of steam per hr. is now normal operating procedure, with CO_2 ranging between 16 and 18%, and smoke of approximately no. 1 Ringelmann density. During one series of tests a capacity of 142,000 lb. steam per hr. was maintained for 3 hr., with CO_2 averaging 18.4%, when burning spent-wood chips having a moisture content of 37.0% and a heating value of 5600 B.t.u. per lb. as fired.

Tests and operating experience with this unit have provided much fundamental data from which newer designs were developed. One of the most important factors established was the conservative continuous "apparent" grate-liberation rate of approximately 1,000,000 B.t.u. per sq. ft. per hr. This rate is conservative because it can be exceeded by a wide margin without distress of any sort. The word "apparent" is used because the liberation rate represents all fuel entering the furnace even though a large portion of its heat content is released in the turbulent zone above the grate. Several units of a similar type are now in various design stages, under construction, or in regular plant service. The cellulose-type fuels to be used are from paper mills, sawmills, sugar mills, naval stores plants, and furfural producing plants. In addition, one unit will operate solely on either low or high-volatile coal. A number will also be equipped for burning oil, natural gas, or coal, either separately or in combination with the wood.

One of these newer units, Fig. 6, installed for a large eastern paper mill, has now been in continuous service for over 20 mo. During this period there have been only seven outages of short duration. One of these resulted from failure of a magnetic-coupling bearing, one from general plant operating difficulties, two for adjustments and correction of expansion clearances, and three for inspection during holiday shutdown of the entire mill. Design capacity is 90,000 lb. steam per hr. at 430 p.s.i. and 613°F. when burning pine bark containing 40% moisture. A capacity of 100,000 lb. per hr. was also guaranteed for coal and fuel oil. Forced and induced-draft fans, however, were provided for an output of 150,000 lb. per hr. in the event the unit possessed the high capacity indicated by experience with the test unit shown in Fig. 5.

The fully water-cooled towerlike furnace has a height of 44 ft. 0 in. from top of grate to underside of roof. Furnace volume is approximately 6200 cu. ft. Distribu-

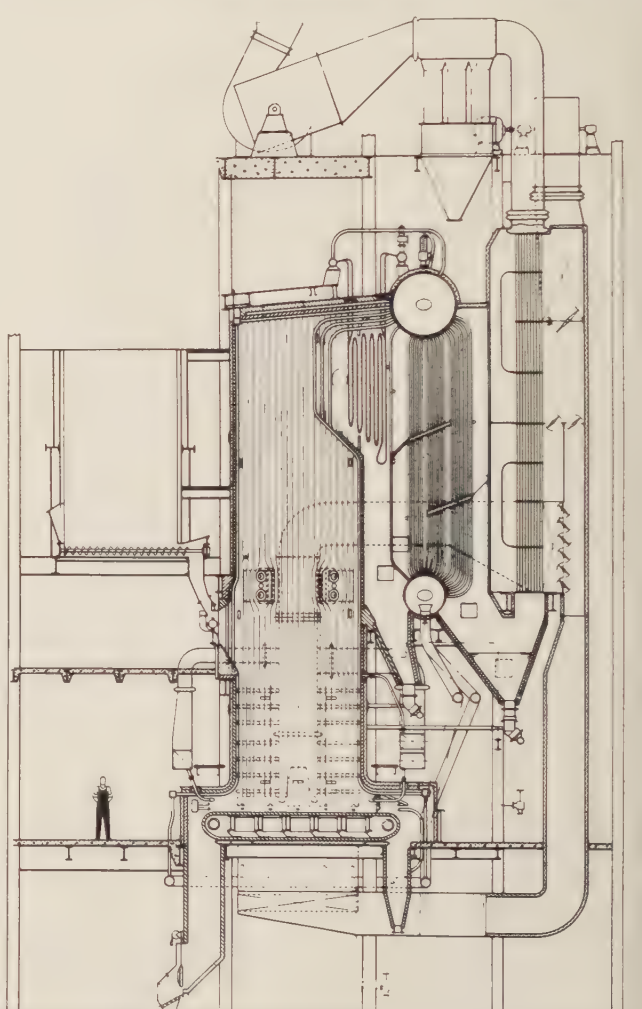

Fig. 6. Unit employing turbulent suspension burning of wood-room refuse, coal, and oil

tors are located 17 ft. 0 in. above grate level and 17 ft. 9 in. below lower edge of entrance into first boiler pass. Stoker grate is 13 ft. 0 in. wide and has a gross area of 192 sq. ft. Air for combustion is available at temperatures up to 550°F., and the undergrate air supply may be tempered to 350°F. through use of by-pass damper.

At design capacity, with wood fuel, furnace liberation rate is 19,600 B.t.u. per cu. ft. per hr., and grate heat release rate is 610,000 B.t.u. per sq. ft. Predicted efficiency is 75.0%.

The tangential overfire-air nozzles are located in the furnace sidewalls between distributors and top of grate. In addition, two rows of horizontally opposed nozzles are located 18 in. above front and rear ends of the stoker. A third row of horizontal nozzles is located in the rear wall at an elevation of 13 ft. 0 in. above grate level. Four sets of tangential oil burners, with intermediate air nozzles, are installed in the side walls approximately 3 ft. 6 in. above distributor level. Overfire jets, in addition to supplying the larger portion of air for combustion are also used to distribute the residual fuel. Thus the distributors throw fuel into the furnace where it is then swirled around and spread out by these jets and then uniformly deposited on the grate.

A large live-bottom surge bin is located in front of the unit above distributor level. Sixteen helicoid screws discharge the feed into four distributors. Inasmuch as coal may also be burned, these screws are driven by four variable-speed motors having a speed range of 50–1 to assure positive feed control.

A multitube dust collector is installed between air-heater outlet and induced-draft fan inlet. The fly ash reinjection system returns all collected carry-over to the lower part of the furnace through four nozzles in the rear wall and two nozzles in the side walls. In the original concept of turbulent suspension burning, it was assumed that the use of extreme turbulence in a tall furnace would produce no more flyash carry-over than obtained with conventional spreader firing. Many tests have shown this to be a correct assumption, even though 100% reinjection is used.

At present, the wood room of this mill is operated 16 hr. per day, and no storage area is provided for excess wood-refuse production. Consequently, this refuse is burned at the rate at which it is produced, except for some over-run which is used to provide a full bin to carry the unit, at reduced load, over the daily 8 hr. wood-room shutdown period. The wood for this unit is a

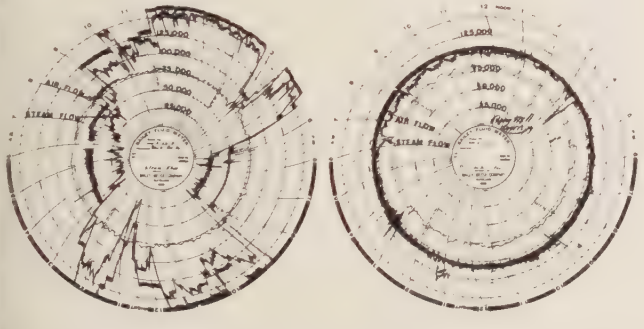

Fig. 7. Typical steam-flow charts showing performance characteristics available in units employing turbulent suspension burning

species of pine commonly found along the mideastern coastal areas. It consists mainly of bark together with varying quantities of culls, knots, butt-ends, and other similar wood-room refuse. Moisture content varies from 30 to 50%. A representative moisture-free proximate analysis is as follows: volatile matter 75.42%; fixed carbon 23.04%; ash 1.54%; B.t.u. per lb. 9260. High-speed rotating-cylinder knife hogs are used to assure well-sized fuel at all times. The use of this equipment adds to steam production costs, but these are more than offset by savings in purchased fuel. Furthermore, relatively uniform size consist facilitates feeding.

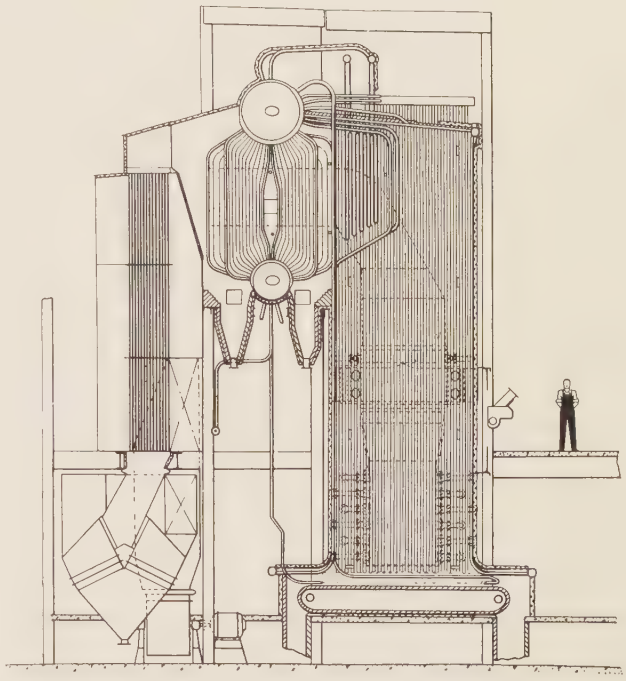

Fig. 8. Modified design of unit for turbulent suspension burning which permits extensive standardization

Operating flexibility of this unit is well illustrated by the two typical steam-flow charts in Fig. 7. The right one shows a 24-hr. record of almost steady steam output at approximately 100,000 lb. per hr. This was part of a three-day run during which the fuel was low-volatile (15%) semibituminous coal. The left chart is an excellent example of wide-range flexibility when burning wood at variable wood-room production rate. Actual load varied from a minimum of 10,000 lb. per hr. to a maximum of 160,000 lb. per hr. with sudden increases or decreases of as much as 125,000 lb. per hr. For the period from 11:30 a.m. to 2:45 p.m. average capacity was approximately 160,000 lb. with a corresponding grate heat-release rate of 1,260,000 B.t.u. per sq. ft. per hr. A more detailed discussion of this unit's performance was presented in a paper by R. Ellwanger (*3*) before the TAPPI meeting in Richmond during September, 1951, in which he said:

"The following heat balance tabulation illustrates typical performance at a rating of 130,000 lb. steam per hr.:

Heat loss due to dry gas	5.9%
Heat loss due to moisture and hydrogen in fuel	13.7%
Heat loss due to carbon monoxide	0.2%
Heat loss due to combustible in refuse	1.0%
Heat loss due to radiation	0.5%
Actual boiler efficiency by difference	78.7%
Guaranteed boiler efficiency at 90,000 lb. steam per hr.	75.0%

"It is interesting to note that the unit is often operated at a capacity of 160,000 lb. per hr. for 3 or 4 hr."

Mr. Ellwanger further states: "Several performance

tests have indicated the total carbon loss to the stack and ashpit is of the magnitude of 1.0%, which results are obtainable principally because of the design of the furnace and jets, as well as efficiency of the reinjection system."

Operating tests, when burning fuel oil, low-volatile or high-volatile coal, have repeatedly shown that guaranteed capacities are also easily exceeded. On one occasion an output of 160,000 lb. per hr. was maintained without difficulty with high-volatile (35%) bituminous coal; in fact, had additional fan capacity been available, the limit might well have been raised to somewhere between 175,000 and 200,000 lb. steam per hr.

For operation with coal it is necessary to use the live-bottom bin, with its 16 screw conveyors, as a feeder. While this feeding arrangement is quite satisfactory for bulky wood-room refuse, the control is somewhat erratic with concentrated fuels such as coal. Nevertheless, as indicated by the left chart in Fig. 7, it is possible even without close control of feed to maintain satisfactory performance. On a number of occasions varying mixtures of wood and coal have been used even though this operation in conventional installations frequently results in heavy fuel-bed clinker formation. With turbulent suspension burning, and its uniform distribution to the grate, there were no signs of distressed areas at any time. In fact, the performance was so satisfactory that there is no hesitancy in using almost any ratio of coal to wood, provided separate feeders are installed. Discharge of fuel from the wood and from the coal feed is simultaneously conveyed to the distributor where mixing occurs. With this arrangement controls may be applied to maintain constant capacity by changing coal-feed rate to compensate for variations in available wood supply.

When burning fuel oil only, all combustion air is supplied in the immediate vicinity of the atomizing nozzles. Under these conditions it is interesting to note the very narrow band in which combustion is completed. The whirling and highly turbulent mass of burning oil vapor rapidly spins around in this band which is not much more than 12 to 14 ft. wide. Immediately below and above this zone the furnace atmosphere is absolutely clear, even though excess air is held to a very low level. This action clearly demonstrates that high turbulence, properly applied, will accelerate completion of the combustion process. A contributing factor is the increased time element during which individual particles of burning fuel may make one or more circuits of the furnace perimeter.

Mr. Ellwanger (*3*) sums up the present status as follows: "The development of this unit and its auxiliaries has advanced bark refuse to the role of a low-cost substitute fuel capable of supplying steam to power-plant header through the medium of the more dependable steam generator." Notwithstanding the extremely satisfactory performance of this unit, every advantage will be taken to modify designs in the interest of still further improving operating characteristics. Some of the more recent modifications are illustrated by the unit shown in Fig. 8. Except for minor changes in arrangement of tangential nozzles and elimination of the three horizontal jet rows, the furnace is practically the same as for the unit in Fig. 7. The pendant superheater has been moved forward into the upper part of the furnace so that it now conforms more closely to those used with chemical-recovery units. A single-pass baffleless boiler has been substituted for the previously used three-pass type. This newer unit lends itself to design standardization in which capacity is a direct function of furnace width.

We have discussed briefly many of the more important characteristics of turbulent suspension burning. As additional units are placed in service, present design limitations will, no doubt, be widened through additional and more accurately established operating data.

Regardless of method employed for firing, fuel size is an important factor which has considerable effect on furnace performance. It may be stated broadly that any wood refuse which can be handled by controllable feeding systems may also be used for cone burning or spreader stokers. Operating results will, however, favor those installations where the oversize is hogged and size consist is maintained as constant as is reasonably possible.

For turbulent suspension burning we have referred to a design heat-release rate of 1,000,000 B.t.u. per sq. ft. of grate per hr. without establishing any limiting factors. Selection of the actual rate to be used, however, is influenced by fuel size consist. Any considerable increase in size of the larger particles will make it necessary to carry out a greater portion of burning at grate level and thereby reduce the quantity of air used overfire. Consequently a range of from 900,000 to 1,100,000 B.t.u. per sq. ft. will prove adequate for usual variations in fuel size normally encountered. Further accumulation of a wide variety in operating experiences together with additional design changes will, no doubt, increase materially these presently established liberation rates.

It is of interest at this point to recall that when using wet-wood fuel for cone burning the design is based on an approximate grate-release rate of 500,000 B.t.u. per sq. ft. Efficiency is in the order of 58%. Maximum effective grate length for a single cone is 10 ft. 0 in. Under these conditions capacity per foot of furnace width will be approximately 2750 lb. steam per hr. For conventional spreader installations liberation rate is 750,000 B.t.u. per sq. ft. efficiency 70% provided an air heater is used, and effective grate length 12 ft. 0 in. In this case the resulting capacity is 6000 lb. steam per ft. furnace width. With turbulent suspension burning the grate length may be 16 ft. 0 in., or perhaps even longer. Using an efficiency of 78.7% as reported by Mr. Ellwanger (*3*), and a grate release of 1,000,000 B.t.u. per sq. ft., the corresponding capacity will then be 12,000 lb. steam per ft. furnace width. This capacity-width factor, together with the ability of turbulent suspension burning to quickly follow changes in steam demand and also operate over a wide load range provides the yardstick whereby value of this new development may be appraised.

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Purified Hardwood Pulps for Chemical Conversion

I. Aspen Sulphite and Prehydrolysis-Sulphate Pulps

F. A. SIMMONDS, R. M. KINGSBURY, J. S. MARTIN, and E. L. KELLER

Purified aspen pulps suitable for chemical conversion were made at the Forest Products Laboratory by the ammonia-base sulphite process, using a liquor relatively low in combined sulphur dioxide, and by the prehydrolysis-sulphate process, using only a water hydrolysis. Purification involved chlorination, hot or cold alkaline extraction, and treatment with sodium hypochlorite and chlorine dioxide. The sulphite pulp, obtained in a yield of 51%, had an alpha-cellulose content of 87%, a pentosan content of 5.1%, and a viscosity of 37.4 cp. when dispersed at 0.5% concentration in cupriethylenediamine. The yield of pulp purified by hot extraction was 37.7%; alpha-cellulose content, 94.4%; pentosan content, 1.5%; and viscosity, 30 cp. The yield of pulp purified by cold extraction was 44.4%; alpha-cellulose content, 96.3%; pentosan content, 0.3%; and viscosity, 22 cp. The prehydrolysis-sulphate pulp, obtained in a yield of 42%, had an alpha-cellulose content of 92%, a pentosan content of 2.8%, and a viscosity of 37.6 cp. The yield of pulp purified by cold alkaline extraction and treatment with chlorine dioxide was 38.2%; alpha-cellulose content, 97.3 cp.; pentosan content, 2%; and viscosity, 18.4 cp. For pulp purified by hot extraction and treatment with sodium hypochlorite the yield was 37.6%; alpha-cellulose content, 94.7%; pentosan content, 2.2%; and viscosity, 12.5 cp. The yield of pulp purified by hot extraction and treatment with chlorine dioxide was 37.7%; alpha-cellulose content, 95.5%; pentosan content, 2.5%; and viscosity, 16.3%. At an industrial laboratory, the two purified sulphite pulps and the two sulphate pulps purified by hot alkaline extraction were acetylated satisfactorily and made into yarn. The experimental cellulose acetate yarns obtained were as strong as yarn made from a commercial softwood sulphite pulp of acetylation grade.

PRODUCTION of purified pulp for the viscose, acetylation, and nitration processes offers an important possibility for increasing the use of hardwoods. In fact, it is often said that it may prove more advantageous to use some species of hardwoods for this purpose than for the papermaking pulps in which strength is more critical.

A viscose-film grade of pulp is made in this country from northern hardwoods by the sulphite process, and a viscose-rayon grade, understood to be satisfactory even for tire cord, is made from southern hardwoods by an alkaline pulping process. It is also understood that a viscose-film grade is made in Canada largely from hardwood by the sulphite process; an acetylation grade is made in Sweden from aspen and a viscose-film grade from birch, both by the sulphite process; and a viscose grade is made in France from chestnut by a prehydrolysis-caustic soda process. Viscose grades are made in Germany from beech by the sulphite process; and, at one time, a pulp satisfactory for acetylation was produced by the nitric acid process. Beech is also used for the production of purified pulps in Austria and Italy (*1*).

Insofar as is known, hardwood pulp for acetylation is not made in this country. Recently, an investigation was undertaken at the Forest Products Laboratory to develop a combination of pulping and purification procedures for producing from aspen a pulp suitable for cellulose acetate yarn. It was desired to obtain purified pulps containing 94 to 97% of alpha-cellulose and as little residual pentosans as feasible and having a minimum viscosity of 19 cp. when dispersed at 0.5% concentration in cupriethylenediamine. For pulping, both the sulphite and prehydrolysis-sulphate processes were used, and for purification of the pulp, both the hot and cold alkaline extraction processes. The work on sulphite pulps was done in cooperation with the Forest Products Division of the Michigan College of Mining and Technology, Houghton, Mich.

LITERATURE REVIEW

Citations of several literature reviews and certain later articles up to late 1951 dealing with problems of pulping and purification in the production, especially from hardwoods, of pulps for chemical conversion and the characteristics of this type of pulp are given elsewhere (*18*).

Literature specific to wood pulp for acetylation is, unfortunately, not abundant. Pulp as free from hemicelluloses as possible is clearly one necessity, however. The need has been stressed for the quantitative measurement of hemicelluloses and their association with varying chain-length fractions in all types of pulps for chemical conversion (*4*).

With the progressive removal of pentosans in the preparation of pulps by the prehydrolysis-sulphate pulping process, haze in solutions of cellulose acetates made from these pulps was decreased to the level of that from a commercial pulp used, at that time, for the commercial production of cellulose acetate (*10*). Earlier publications from the same industrial laboratory dealt broadly with purified wood pulp and the influences of variables of sulphite pulping and of purification, especially on the removal of pentosans from northern hardwoods (*15*, *16*). It is specified that a wood pulp containing more than 1% of pentosans does not undergo acetylation satisfactorily. At the same degree of purification, however, a hardwood pulp undergoes acetylation as well as a softwood pulp. Elsewhere it is reported that beech and mangrove pulps containing 1% of pentosans insoluble in a 7% solution of sodium hydroxide were satisfactory for acetylation. These pulps were made by a process involving prehydrolysis followed by alkaline cooking (*8*).

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There are numerous instances showing that some of the xylan in hardwoods remains in the alpha-cellulose of pulps produced from these woods and that the insolubility of diacetylxylan formed on acetylation of the pulp is likely to be an adverse factor in the filtration of cellulose acetate solutions (*14*). Pentosans, uronic acids, and calcium present in purified wood pulp have been found to persist in the cellulose acetate and are considered causes of haze in the acetate solution (*3*). The appearance in viscose yarn of practically all of the pentosans of a hardwood pulp (which amounted to about 7.5% and remained in the alpha-cellulose residue) has been reported (*18*).

Comparisons of reactivity toward acetylation and the characteristics of the acetates show wood pulp, even at a high degree of purity, to be inferior to cotton linter pulp (*3, 5, 6, 9*). Reasons given for this disparity include noncellulosic impurities, nonuniformity in reactivity of fibers, less favorable molecular weight distribution and higher carboxyl content causing higher sensitivity on the part of the wood pulp to calcium and magnesium ions.

Although there is disagreement that, in the wet condition, cold-alkali-processed pulp is less reactive toward acetylation than hot-alkali-processed pulp, there is agreement that it is less reactive after drying (*5, 15*). At the same increase in the proportion of alpha-cellulose in the purification of hardwood sulphite pulp, a higher yield was obtained when extraction was done by the cold alkali process at a concentration not above 8% nor a temperature below 10°C. than when done by the hot alkali process (*16*).

Consideration has been given also to the cell composition of hardwood pulps. The cell fraction commonly termed "fines" is appreciably higher in lignin, ether solubles, and acid-alcohol-soluble wax than the fibers, and there are also other differences (*13, 15*).

With no concern as to immediate practicability, it is pertinent to remark that aspen unbleached sulphate pulp high in alpha-cellulose and low in pentosans was produced without the aid of prehydrolysis, by means of continuous flow of cooking liquor to maintain constant concentration of chemicals (*17*). This work was confirmed in principle by pulping experiments on scrub oak in which the pulping process comprised a 10 to 30-min. sulphate cooking treatment with the chemical concentration essentially constant, applied to disintegrated chips previously steamed (*11*). It is noteworthy that one of the scrub oak pulps after purification was indicated by test at an industrial laboratory to be satisfactory for cellulose acetate. It is also of interest that when the yields of carbohydrate at equal pentosan content and based on carbohydrate in the wood are calculated for the unbleached aspen and scrub oak pulps just mentioned and the unbleached prehydrolysis-sulphate aspen pulp produced in the investigation reported in this paper, the values are essentially the same. Estimation of degree of polymerization from disperse viscosity values gives values of about 800 for the unbleached aspen pulp produced by continuous flow of liquor and about 1500 for the unbleached prehydrolysis-sulphate aspen pulp; a value of 1250 was reported for the scrub oak sulphate pulp after it was bleached with sodium chlorite (*11*).

TEST METHODS APPLIED TO THE ASPEN WOOD AND PULPS

Test methods used in the work reported here are given elsewhere (*18*). In addition, a procedure was developed for acetylating pulp samples and measuring the haze and insoluble residue of the primary acetic acid dope.

PREPARATION OF UNBLEACHED ASPEN PULPS

Aspen Wood

Test values in Table I show that the aspen wood, grown in Michigan, was typical of the species. Routine visual inspection and the solubility test in 1% caustic soda proved it to be in sound condition. Attention has been called to indications of the absence of beta-cellulose in wood (*18*), and the aspen, under the conditions of analysis, proved another instance of this property.

Prehydrolysis-Sulphate Pulp

Since previous results of prehydrolysis-sulphate pulping with other samples of aspen were available, only a check small-scale pulping trial on the aspen used in this work was necessary. Pulping conditions were selected for producing an unbleached prehydrolysis-sulphate pulp low in pentosan content yet high enough in disperse viscosity to allow some margin for further lowering of viscosity by purification.

Prehydrolysis was done with water only in a 14-cu. ft. digester lined with type 316 stainless steel. The temperature was increased to 170°C. over a period of 1.5 hr. and maintained there for 0.5 hr. Hydrolyzate was drained from the bottom of the digester under existing pressure, but an amount of this liquor equal to about one half the weight of the original wood was retained by the chips. The pH value of the hydrolyzate was 3.8.

For the sulphate pulping of the prehydrolyzed chips, the cooking liquor comprised 12.34% of sodium hydroxide and 5.16% of sodium sulphide (30% sulphidity) based on the wood; the liquor-wood ratio was 4 to 1. The temperature was increased to 170°C. in 1 hr. and maintained there for 1.5 hr. The resultant pulp was washed in a blow pit, screened (seven-cut, flat

Table I. Test Values for Aspen Wood and the Unbleached Pulps Purified for Spinning Trials[a]

Test value	Material: Wood	Material: Prehydrolysis-sulphate pulp	Material: Sulphite pulp
Yield of unbleached pulp, %		42.0	51.0
Lignin, %	18.4	1.0	0.8
Permanganate number		5.9	4.7
Alpha-cellulose:[b]			
Based on wood, %	47.4	38.5	44.4
Based on pulp, %		92.0	87.0
Beta-cellulose,[b] %	0	3.2	3.2
Gamma-cellulose,[b] %	30.4	3.5	8.3
Total pentosans, %	18.6	2.8	5.1
Solubility in:			
Ether, %	1.2	0.6	0.66
1% NaOH, %	19.4	...	...
7.14% NaOH, %	...	...	...
Disperse viscosity,[c] cp.	...	37.6	37.4
Ash, %	0.3	0.5	0.1
Iron as Fe, p.p.m.	...	20	12.0

[a] Sample of wood for testing taken from chips used for pulping. Sulphite pulps, 5492-93. Sulphate pulps, 4017-18-19.
[b] Determined on holocellulose.
[c] Pulp at 0.5% concentration in cupriethylenediamine.

plate), and recovered by means of a wet machine. The yield of unbleached pulp was 42%. Test values for the pulp are given in Table I.

Ammonia-Base Sulphite Pulps

In production of ammonia-base sulphite pulps from the aspen, cooking liquor relatively low in amount of combined sulphur dioxide was used to facilitate hydrolysis of hemicelluloses. The series of digestions listed in Table II were made to determine the trend of relation between pulping conditions within a practicable range and the permanganate number, disperse viscosity, and pentosan content of the resultant pulps.

The pentosan contents of the experimental aspen sulphite pulps ranged from 3.4 to 5.1%. The effectiveness of a low amount of combined sulphur dioxide in the cooking liquor in hydrolyzing pentosans becomes apparent when it is recalled that papermaking grades of aspen pulp are made with 1% or a little more of combined sulphur dioxide and that they contain from 6 to 10% of pentosans. The trend of the effect of increasing the duration of cooking at maximum temperature in decreasing pulp yield, pentosan content, and disperse viscosity of the unbleached pulp is also shown by the data in Table II. The pulp identified by nos. 5492-93, intended as a replicate of digestion 964, was made in pilot-plant equipment to provide pulp for spinning trials. Test values for this pulp are given in Table I.

COMPARISON OF UNBLEACHED SULPHITE AND PREHYDROLYSIS-SULPHATE PULPS

The unbleached sulphite and prehydrolysis-sulphate pulps were approximately equal in lignin content, disperse viscosity, solubility in ether, and close in permanganate number, but differed in percentage of alpha-cellulose essentially in proportion to the difference in percentage of gamma-cellulose (Table I). The outstanding difference was in the amount of alpha-cellulose recovered in the pulping—81% with the prehydrolysis-sulphate process and 94% with the sulphite process. This difference was a result of the widely recognized difference in the action of the sulphite and sulphate pulping processes on the carbohydrates of wood.

In an investigation elsewhere of the losses of cellulose and wood sugars in the chemical pulping of beech, the yield of cellulose obtained with sulphite pulping was 5 percentage points higher than with prehydrolysis-sulphate pulping (*12*). Cellulose was defined as the carbohydrate isolated under specified conditions and calculated on the pentosan-free basis and having a minimum average degree of polymerization of 1000. As in the work reported in this paper, the alpha-cellulose content of the unbleached prehydrolysis-sulphate beech pulp was higher than that of the sulphite pulp obtained with special but undescribed conditions of digestion, and, likewise, the two beech pulps were equal in disperse viscosity. In contrast, the pentosan contents of the two beech pulps were equal.

PULP PURIFICATION

Prehydrolysis-Sulphate Pulp

For spinning trials, three purified pulps were prepared from the unbleached prehydrolysis-sulphate pulp (Table I) by these sequences: (1) a quantity of the pulp was chlorinated and then divided into two portions. (2) One portion was subjected to a hot alkaline extraction, again divided, and one part treated with sodium hypochlorite and the other with a mixture commonly referred to as chlorine dioxide and chlorine. (3) The second portion of the chlorinated pulp was subjected to a cold alkaline extraction followed by treatments with sodium hypochlorite and chlorine dioxide-chlorine in that order. Specific conditions are in Table III.

Chlorination. It was believed that a high partition of chlorine to the chlorination stage would be favorable to pulp quality and that an amount requiring 1.5 hr. for consumption would not be harmful. This amount was determined by trials, and it represented 75% of the total chlorine applied in conjunction with sodium hypochlorite and 60% of that applied in conjunction with the chlorine dioxide-chlorine mixture. When the chlorine was applied as shown in Table III, the disperse viscosity of the pulp was decreased to 23.6 cp. from 37.6 cp., which is not an excessive decrease for this type of pulp.

Hot Alkaline Extraction. There was no difference in effect on the proportion of alpha-cellulose and but little difference in effect on the disperse viscosity of the chlorinated pulp between: (1) extraction with 5% by weight of sodium hydroxide applied at 0.6% concentration and 70° C. for 1 hr., and (2) extraction with 10% by weight of sodium hydroxide applied at 1.2% concentration and 115°C. for 1.5 hr. Essentially the milder of these extractions was actually applied, and it decreased the disperse viscosity of the chlorinated pulp to about 22 cp.

Treatment with Hypochlorite. Amounts of 0.5 and 1.0% of available chlorine in the form of sodium hypochlorite were applied to samples of the pulp after the hot alkaline extraction. The resultant pulps were

Table II. Conditions and Certain Results of Ammonia-Base Sulphite Digestions of Aspen

Digestion No.	Acid concentration[a] Total SO_2, %	Acid concentration[a] Combined SO_2, %	Maximum temperature, °C.	Time at maximum temperature, hr.	Total time,[b] hr.	Combined SO_2 test at end,[c] %	Screened pulp yield, %	Screenings, %	Permanganate No.	Disperse viscosity,[d] cps.	Total pentosans, %
963	6.51	0.72	135	2.5	8.5	−0.12	51.2	0.2	3.1	29.9	5.1
964	6.48	0.51	135	1.4	7.4	−0.22	50.8	0.5	4.4	29.0	4.5
967	6 67	0.53	135	1.9	7.9	−0.29	49.4	0.2	3.2	18.9	3.8
966	6.27	0.53	135	2.2	8.2	...	48.6	0.5	3.6	15.6	3.4
965	6.52	0.52	145	0.6	6.0[e]	−0.10	51.7	0.8	6.8	46.0	5.2
5492-93[f]	6.00	0.48	135	1.5	7.5	−0.20	51.0	...	4.7	37.4	5.1

[a] Liquor-wood ratio of 5.45 to 1, not including moisture in wood.
[b] Includes 2 hr. to 105°C., 1 hr. at 105°C., and 3 hr. to 135°C.
[c] Sander test.
[d] Viscosity values are for pulp at 0.5% concentration in cupriethylenediamine.
[e] Includes 2 hr. to 105°C., 1 hr. at 105°C., 2.25 hr. to 134°C., and 0.2 hr. to 145°C.
[f] Pilot plant digestions; others were small-scale using about 7 lb. of chips.

equal in brightness (83%), but the less severely treated pulp had a disperse viscosity of 12.2 cp. and the other pulp, 5.4 cp. Since a minimum viscosity of 19 cp. had been specified, the lower amount of hypochlorite was applied to a larger batch of pulp as shown in Table III.

Treatment with Chlorine Dioxide-Chlorine Mixture. Results of trials showed that 1% of available chlorine in a mixture in which the chlorine dioxide-chlorine ratio was 2 to 1 was satisfactory.

Coal Alkaline Extraction. Application to the chlorinated pulp of caustic soda solutions of 5 and 10% concentration at 24°C. and 10% concentration at 35°C. resulted in trial pulps having respective alpha-cellulose contents of 96.8, 98.2, and 97.9%. The viscosity values for the last two pulps, 23 and 22.7 cp., were higher than the specified minimum, however. Consequently, the concentration of 5% was used in extracting the larger quantity of pulp.

Oxidation Sequence. Trials were made comparing the chlorine dioxide-chlorine mixture as the only oxidation stage following cold alkaline extraction with an oxidation treatment in which the chlorine dioxide-chlorine treatment was preceded by an oxidation stage in which sodium hypochlorite was used. The results indicated that there was possibly a slight advantage with respect to brightness and viscosity by using the two-stage oxidation treatment as shown in Table III.

Exploratory Ammonia-Base Sulphite Pulps

Pulps 964 and 967. Of the exploratory pulps of the 900 series listed in Table II, nos. 964 and 967 were considered the most promising and were therefore further tested by purification trials. The details of these trials and certain of their effects are combined in Table IV for convenience.

It is recalled that a minimum disperse viscosity specification of 19 cp. for purified pulp (0.5% concentration in cupriethylenediamine) had been accepted. With this criterion, pulp no. 964 could be considered superior to pulp no. 967 as providing more leeway in decrease of viscosity during purification. A possible modification of the importance of this specification will be discussed later.

It can be calculated plausibly from available data that the proportion of alpha-cellulose in pulp no. 964 was about 92%. In comparison, the larger-scale pulp composite (digestions 5492-93, Table II) purified for spinning trials had an alpha-cellulose content of 87% by analysis (Table I).

Hot Alkaline Extraction of Pulps 964 and 967. The results of the trials of hot caustic soda extraction of pulp 964 showed that a drastic treatment was necessary to increase the proportion of alpha-cellulose into the specified range of 94 to 97%. In attaining this proportion, there was a considerable sacrifice in yield as has been observed elsewhere (*16*). If one accepts the calculated alpha-cellulose value of 92% for unbleached pulp 964, the conclusion follows that this sulphite pulp was considerably more resistant to hot alkaline purification than the unbleached prehydrolysis-sulphate pulp in which the proportion of alpha-cellulose was 92% by analysis (Table I).

Compared to pulp 964, pulp 967 was the result of a somewhat greater degree of digestion. Its behavior under hot alkaline extraction tended to confirm the

Table III. Multiple-Stage Purification of Aspen Prehydrolysis-Sulphate and Sulphite Pulps by Hot and Cold Alkaline Extraction Processes

Type of unbleached pulp	*Prehydrolysis-sulphate*[a]			*Ammonia-base sulphite*[b]	
Type of alkaline extraction	*Hot*		*Cold*	*Hot*	*Cold*
Bleach No.	*2223*	*2232*	*2224*	*2195*	*2182*
Chlorination:[c]					
Available chlorine, %	1.5	1.5	1.5	1.5	1.5
Temperature, °C.	25	25	25	25	25
Pulp consistence, %	3	3	3	3	3
Duration, min.	90	90	90	60	60
Extraction for 1 hr.:					
Sodium hydroxide, %	5.5	5.5	62.8	...	...
Concentration, %	0.6	0.6	5.0	...	...
Temperature, °C.	79	79	25	...	...
Pulp consistence, %	11.0	11.0	7.4	...	...
Sodium hypochlorite:					
Available chlorine, %	0.5	...	0.3	0.3	0.4
Temperature, °C.	33	...	32	27	31
Pulp consistence, %	10	...	8	3	10
Alkalinity, pH	9.6–9.2	...	11.8–11.3	8.0–7.3	9.3–8.8
Duration, min.	300	...	4	60	170
Extraction:					
Sodium hydroxide, %	...	...	...	17	135
Concentration, %	...	...	...	1.9	15.0
Temperature, °C.	...	...	...	130	25
Pulp consistence, %	...	...	...	10	10
Duration, min.	...	...	...	90	60
Chlorine dioxide-chlorine:[d]					
Available chlorine, %	...	1.0[e]	0.7[e]	0.4[f]	0.4[f]
Temperature, °C.	...	39	39	38	40
Pulp consistence, %	...	8	8	3	4
Alkalinity, pH	...	7.1–7.3	7.5–7.3	6.9–3.0	7.2–3.0
Duration, min.	...	240	240	180	180
Steeping	[g]	[g]	[g]	[g]	[g]

[a] Digestions 4017-18-19.
[b] Digestions 5492-93.
[c] Values for chemicals in each purification stage based on unbleached pulp.
[d] From reaction of sodium chlorite and excess chlorine. The amount of chlorine required for generating chlorine dioxide is considered as 0.2 of the chlorine in the chlorite.
[e] Chlorine dioxide-chlorine ratio of 2 to 1.
[f] Chlorine dioxide-chlorine ratio of 3 to 1.
[g] In order to decrease iron content, the pulps were given a final steeping at pH 1.5 (adjusted with hydrochloric acid), 3.5% consistence, and 25°C. for 3 hr. followed by complete removal of acid.

indicated difference in the solubility of the sulphite and prehydrolysis-sulphate pulps in hot caustic soda at the low concentration range of 0.5 to 2%. It has been stated that in the hot alkaline extraction of sulphite pulps, the amount of caustic soda is more important than the concentration (*16*).

Under the conditions applied in bleaches 2140 and 2144, Table IV, intended as replicates, the requirements for alpha-cellulose and disperse viscosity were met and the brightness of the pulp was fairly good.

Sodium Chloride in Extraction. As an incidental test, the addition of sodium chloride in hot alkaline extraction was tried as an aid in the removal of pentosans in the pairs of bleaches 2137-38 and 2135-36 (Table IV). Under the conditions used, the sodium chloride had no effect of any sort.

Ammonia-Base Sulphite Pulp for Spinning Trials

The ammonia-base sulphite pulp prepared in quantity for use in spinning trials was the composite of digestions 5492-93, Table II. Test values (Table I) show that in degree of pulping, this composite pulp was somewhat less advanced than exploratory pulp 964 (Table IV), although the differences are within the range often experienced in experimental replication.

Hot Alkaline Purification. The lesser degree of pulping of the composite pulp did appear to impose a somewhat different problem in its purification by hot alkaline extraction. The alpha-cellulose content attained in purification trials, although admittedly these trials were few, and in the final preparation of the composite pulp was in no instance so high as that attained in the hot alkaline purification of pulp 964. Thus, in attempting to increase the proportion of alpha-cellulose in the purified pulp by increasing the severity of extraction, a destruction of the alpha-cellulose ensued in an amount roughly proportional to the amount of the nonalpha-cellulose carbohydrate material removed. Evidence indicates that the degree of digestion is critical in this connection, since acidic hydrolysis appears more selective in the removal of hemicellulosic material than hot alkaline extraction. This concept has been advanced by other investigators (*4, 8, 16*).

The disperse viscosity of composite pulp 5492-93 was only decreased to 31 cp. from about 38 cp. in the preliminary purification trials. For the purpose of preparing a pulp closer to the minimum specification for viscosity, a purification sequence of chlorination followed by hypochlorite treatment and extraction was selected. Presumably with this order, viscosity can be decreased readily, with control, in the hypochlorite stage immediately following chlorination. Degradation products are removed next in the stage of alkaline extraction, and a final brightening of the pulp can be done under essentially nondegradative conditions. There was a decrease of only 1 cp., however, by the following treatment: (1) 1% of chlorine for 1.5 hr., (2) 0.3% of available chlorine as sodium hypochlorite at 30°C. and a pH of about 9.5 for 70 min., (3) extraction with 15% by weight of caustic soda at 130°C. for 1.5 hr., and (4) 0.5% of available chlorine as a chlorine dioxide-chlorine mixture. When the pH of the reaction in stage 2 was decreased somewhat (9.3 at start and 8.8 at end), viscosity was lowered to 30 cp. Consequently, it was expected that in the purification of composite pulp 5492-93, as shown by bleach 2195, Table III, the relatively low degree of alkalinity in stage 2 would result in a still greater decrease in viscosity. Actually, the final pulp had a disperse viscosity of 30 cp.

Cold Alkaline Purification. The chlorination-oxidation sequence was used also in purifying a sulphite pulp by cold alkaline extraction as shown in bleach 2182, Table III. The sulphite pulp was more resistant than the prehydrolysis-sulphate pulp to cold alkaline extraction.

The sulphite pulp prepared by cold extraction was 8 cp. lower in disperse viscosity than that prepared by hot extraction. The two processes appear to differ somewhat in effect on viscosity. For example, a portion of the sulphite pulp subjected to the treatment of stages 1 and 2 of bleach 2182, Table III, was divided

Table IV. Effect of Purification of Exploratory Aspen Ammonia-Base Sulphite Pulps on Pulp Properties

Unbleached pulp No.	967		964					
Type of alkaline extraction	Hot		Hot				Cold	
Bleach No.	2137	2138	2135	2136	2140	2144	2139	2143
Chlorination for 1 hr. at 2% pulp consistence and 25°C.:								
Chlorine, %	0.5	0.5	0.7	0.7	0.7	0.7	0.7	0.7
Extraction at 10% consistence:								
Sodium hydroxide, %	10	10[a]	10	10[a]	15	15	90	135
Concentration, %	1	1	1	1	1.7	1.7	10	15
Temperature, °C.	90	90	90	90	130	130	25	25
Duration, min.	1.5[b]	1.5[b]	1.5[b]	1.5[b]	1.5[b]	1.5[b]	1.0	1.0
Sodium hypochlorite at 30°C., 10% pulp consistence, 0.3% available chlorine:								
Alkalinity, pH	9.7 9.4	9.7 9.4	9.6 9.3	9.6-9.3	9 2 9 2	9 5-9.3	8.9 8.8	9.9 9.2
Duration, min.	200	200	210	210	240	240	200	105[c]
Sodium hypochlorite:	...	...	...	...	...	...	...	
Purified pulp:								
Yield:								
Based on pulp, %	89.2	90.5	88.5	88.3	73.3	71.5	88.2	85.6
Based on wood, %	44.1	44.8	44.9	44.8	37.0	36.3	44.8	43.1
Alpha-cellulose:								
Based on pulp, %	93.0	92.0	92.5	92.5	96.4	97.4	95.7	96.6
Based on wood, %	41.0	41.3	41.6	41.5	36.1	35.4	42.8	41.7
Pentosans, %	1.8	1.7	2.5	2.2	...	...	0.3	...
Disperse viscosity, cp.	16.4	16.4	20.2	19.8	25.4	19.2	19.5	13.6
Brightness, %	82.5	82.7	84.0	84.1	85.3	85.1	82.9	82.8

[a] Two per cent of sodium chloride was added as possible aid in pentosan removal.
[b] Includes temperature increase period of 45 min.
[c] Fifteen hundredths per cent of available chlorine, pH 9.8–9.4, 30°C., 10% pulp consistence, 150 min.

into two parts, and one part was given a hot extraction and the other a cold extraction. The viscosity value for the cold-extracted pulp was 26.1 cp. and for the hot-extracted pulp, 29.5 cp.

The chlorine dioxide-chlorine treatment used for the cold-extracted pulp (bleach 2182, Table III), as well as for the hot-extracted pulp (bleach 2195, Table III) did not destroy alpha-cellulose, as determined by analyses before and after the treatment.

With disperse viscosity as the criterion, sulphite pulp after cold alkaline extraction appeared to be more sensitive to oxidation by sodium hypochlorite than sulphite pulp after hot alkaline extraction. For example, when pulp after stage 3 of bleach 2182, Table III, and having a disperse viscosity of 26.1 cp. was treated with, respectively, 0.2 and 0.4% of chlorine, viscosity values for the resultant pulps were 13.2 and 9.5 cp.

YIELDS OF PURIFIED PULPS

For information on the relation of conditions of pulp preparation to (1) the yields of purified pulps and (2) the percentage recovery of the alpha-cellulose of the wood, reference should be made to Tables IV and V. The advantages of using percentage recovery of alpha-cellulose in discussions involving yield are: (1) it is a basis for comparing any combination of wood and process, and (2) it emphasizes the fact that the alpha-cellulose of the wood is the material sought.

With no implication of generalization, the available data show that with prehydrolysis-sulphate pulping, combined with hot or cold alkaline extraction treatment, from 79 to 82% of the alpha-cellulose of the wood was recovered when the alpha-cellulose content of the purified pulp was 95 to 97%. In sharp contrast, when this proportion of alpha-cellulose was attained in the purified pulp with the combination of sulphite pulping and hot alkaline extraction, the recovery of alpha-cellulose was only 75% because much more drastic purification conditions were necessary. Furthermore, this lower recovery persisted over the range of degree of sulphite pulping within which the minimum viscosity specification for the purified pulp could be approximated. With the combination of sulphite pulping and cold alkaline extraction, however, 90 to 91% of the alpha-cellulose was recovered.

EVALUATION OF THE PURIFIED PULPS

Usual test values are given in Table V for the purified pulps that were subjected to spinning trials. These data show that as a result of the differences in the procedures of preparation, the experimental purified pulps differed appreciably in pentosan and alpha-cellulose content and in disperse viscosity. In these respects, the variations of the experimental pulps from a commerical softwood sulphite pulp suitable for acetylation ranged from what would be considered unfavorable to favorable. The amount of ether-soluble material in all of the pulps would, in general, be considered undesirably high. It has been shown that the addition of a suitable detergent to an alkaline extraction stage is effective in removing ether-soluble material from pulp (*16*).

Although not a usual test, the experimental pulps and a commercial pulp for comparison were acetylated, and the haze and insoluble residue of the primary acetic acid dopes or gums were measured. The haziness of the dopes made from the experimental pulps was from three to five times greater than that of the dope made from the commercial pulp. A thorough extraction of sulphite pulp from bleach 2182 (Table V) with ether did not decrease its haze-forming tendency.

The purified exploratory sulphite pulp bleach 2137 (Table IV) is noteworthy. Although its alpha-cellulose content was only moderate, it was quite low in pentosans, and its disperse viscosity was only a little below the specification used as a standard in this investigation. The unbleached pulp required only a mild purification, and the recovery of alpha-cellulose was 87%. It would be desirable to evaluate a similar pulp for acetylation.

PRODUCT SUITABILITY TESTS

Viscose Tire Cord

With respect to disperse viscosity, the prehydrolysis-sulphate pulp from bleach 2223 (Table V) was brought within the range of commercial viscose pulps by the use of sodium hypochlorite in the third stage of the purification treatment.

Filtrability of Viscose. In tests at the Forest Products Laboratory, the filtrability of the viscose solution made from pulp 2223 was equal to that from a commercial softwood pulp, when the amount of carbon disulphide used in both xanthations was 35% based on the cellulose in the alkali cellulose. When 33% of carbon disulphide was used, the filtrability of the viscose solution from pulp 2223 was only fair. This sensitivity to the amount of carbon disulphide is believed to mean that the degree of prehydrolysis was insufficient. Laboratory experiments with birch and a constant amount of carbon disulphide show a marked improvement in viscose filtrability with increasing degree of prehydrolysis. The importance of prehydrolysis on the reactivity of the final pulp toward viscose making was stressed recently, and explanation of its beneficial effect was proposed (*4*).

Pulp Sheets for Spinning Trials. In preparation for spinning trials on viscose rayon tire cord at an industrial laboratory,* experimental aspen pulp 2223 was run over the laboratory 12-in.-trim fourdrinier paper machine. The resultant pulp sheet was 0.03 in. thick, weighed 41 grams per sq. ft., and its density was 0.6 gram per cc.

Results of Spinning Trial. The results of spinning trials for viscose rayon tire cord indicated that in quality, the experimental prehydrolysis-sulphate pulp was slightly better than a commercial softwood sulphite pulp and somewhat inferior to a commercial hardwood sulphate pulp. Although the reasons for these differences were not apparent, the relatively high content of ether-soluble material in the aspen pulp was considered at least a manifestation of an adverse characteristic.

The disperse viscosity of the aspen pulp exceeded that of the commercial sulphite pulp by 20% and that of the commercial sulphate pulp by 70%. In processing the aspen pulp, it was necessary to age the alkali cellulose for 45 hr. to obtain a viscose of acceptable

* Tests of the suitability of the pulp for tire cord and interpretation of results were made by E. I. du Pont de Nemours & Co., Inc., Rayon Department, Technical Division, Viscose Research Laboratory, Richmond, Va.

viscosity. This duration was likely twice that required by the commercial hardwood sulphate pulp. It is likely that during this degradation, the amount of very short chain material generated was considerable which may have affected the mechanical properties of the tire cord adversely.

Suitability for Acetylation

Evaluation by a New Method. The suitability of the aspen pulps for acetylation was determined in comparison with a commercial softwood sulphite pulp of acetylation grade at an industrial laboratory.† In the method used, which was developed by that laboratory (*2*), a pulp sample is treated with an acetylating mixture, and, at intervals during the later stages of the reaction, a sample of the acetate gum is removed and tested for filtrability and the viscosity of the filtered gum. Thus, the suitability of the pulp for acetylation "is evaluated in terms of (1) over-all reaction rate, (2) the rate of degradation of the cellulose acetate produced, and (3) the rate of disappearance of filter-plugging particles from the acetylation mixture."

A pulp that yields an acetate gum with a low filter-plugging constant at a high viscosity is considered satisfactory for acetylation.

Results for the Prehydrolysis-Sulphate Pulps. The sample of hot-extracted, hypochlorite-treated prehydrolysis-sulphate aspen pulp (bleach 2223, Table V) was submitted for testing in the wet, bulk condition as a result of repulping the fourdrinier-sheeted pulp prepared for the viscose spinning trial. Before the acetylation test the water associated with the pulp was replaced by acetic acid. Other water-wet pulps were treated likewise. When water is removed from pulp in this way the cellulose is usually more reactive than when the pulp is air or machine-dried.

Under the conditions of the test, the acetate gum obtained from the hot-extracted, hypochlorite-treated aspen pulp was superior in the combination of viscosity and filtrability to that obtained from the commercial softwood sulphite pulp.

The hot-extracted, chlorine dioxide-treated pulp (bleach 2232, Table V) tested in both the dry and wet conditions, gave gums superior to that of the control.

The cold-extracted pulp (bleach 2224, Table V) in the wet condition gave an acetate gum superior to that of the control. The gum prepared from dry pulp, however, was much too low in viscosity when its filtrability value was essentially as good as that of the control. Despite this, the gum contained a large number of unacetylated fibers at the end of the reaction, which presumably was appreciably longer than for the control pulp.

Results for the Sulphite Pulps. The acetate gum obtained from the hot-extracted aspen sulphite pulp in the wet condition (bleach 2195, Table V) was superior to that of the control, but the filtrability of the gum from the dry aspen pulp was definitely inferior.

The cold-extracted pulp (bleach 2182, Table V) was tested only in the original wet condition. The test results indicated this pulp was inferior to the control, but this appeared due at least in part to the presence of fiber aggregates or knots in the purified pulp.

Influence of Pentosans. The aspen pulps that responded favorably under the conditions of the new method for evaluation reacted very rapidly and gave fiber-free gums in appreciably shorter reaction times than did the control pulp. All of the gums from the aspen pulps, however, possessed high haze characteristics that seemed to vary directly with the pentosan content of the pulp. This apparent relation between haze and pentosan content is in accord with the findings in another investigation (*10*).

Additional Interpretation. Drying was shown as an adverse influence on the reactivity of cellulose. It was also shown that cellulose subjected to a strong solution of sodium hydroxide at ordinary temperature is especially sensitive to drying. This effect of drying was also experienced under a different set of acetylation conditions used in spinning trials to determine suit-

† Acetylation tests and interpretation of the results were made by E. I. du Pont de Nemours & Co., Inc., Acetate Research, Waynesboro, Va.

Table V. Yield and Usual Test Values for the Purified Aspen Pulps Prepared for Spinning Trials

Pulping process	*Prehydrolysis-sulphate*[a]			*Ammonia-base sulphite*[b]	
Type of alkaline extraction	*Hot*		*Cold*	*Hot*	*Cold*
Bleach No.	*2223*	*2232*	*2224*	*2195*	*2182*
Brightness, %	81.8	83.4	84.2	84.6	85.8
Pulp yield:					
Based on pulp, %	94.1	94.2	95.5	73.9	87.0
Based on wood, %	39.5	39.5	40.1	37.7	44.4
Alpha-cellulose:					
Based on pulp, %	94.7	95.6	97.3	94.4	96.4
Based on wood, %	37.4	37.8	39.1	35.6	42.8
Recovery, %	79	80	82	75	91
Beta-cellulose, %	2.6	2.1	1.1	3.6	2.7
Gamma-cellulose, %	2.3	1.7	1.4	1.5	0.2
Pentosans, %	2.2	2.5	2.0	1.5	0.3
Solubility in:					
Ether, %	0.37	0.64	0.54	0.35	0.67
7.14% NaOH, %	4.8	4.7	3.7	4.8	7.3
Disperse viscosity,[c] cp.	12.5[d]	16.3[d]	18.4	30	22.1
Ash, %	0.08	0.14	0.16	0.05	0.06
Iron as Fe, p.p.m.	18.5	24.0	18.0	20.0	25.0
Acetate solution:[e]					
Haze, %	...	13	10	10	14
Residue, %	...	0.43	0.3	0.13	0.3

[a] Digestions 4017-18-19.
[b] Digestions 5492-93.
[c] Pulp at 0.5% concentration in cupriethylenediamine.
[d] Value after chlorination was 23.6 cp. and after alkaline extraction, 21.9 cp.
[e] Primary dope. Haze values are per cent of light scattered under conditions of test. Residue is based on pulp. Values for dope from a commercial pulp of acetate grade were: haze, 3%; residue, 0.22%.

ability of the aspen pulps for cellulose acetate yarn. The result with the dry, cold-extracted prehydrolysis-sulphate pulp suggests that there was a general but nonuniform decrease in the number of accessible hydroxyl groups upon drying.

Suitability for Cellulose Acetate Yarn

All five of the aspen pulps produced in quantity (Table V) were submitted to an industrial research laboratory‡ to be tested in spinning trials for cellulose acetate yarn. In addition, two sulphite pulps, one from a calcium-base process and the other from an ammonia-base process, made at the industrial laboratory from a sample of the aspen wood used in this investigation, were tested. Since it is likely that these two pulps were produced under significantly different conditions than those used in making the two sulphite of the five-pulp series, they were considered as two additional independent samples.

The hot-extracted, hypochlorite-treated, prehydrolysis-sulphate pulp (bleach 2223, Table V) was submitted in the form of fourdrinier-dried sheets; the other pulps were submitted in wet bulk form.

Acetylation and Filtrability Characteristics. The cold-extracted prehydrolysis-sulphate pulp (bleach 2224, Table V) could not be acetylated by any activation treatment considered practicable. For this reason, a spinning trial was not made on this pulp.

The other six experimental aspen pulps, including the two sulphite pulps made at the industrial laboratory, were easily controlled in the acetylation reaction. They yielded cellulose acetates having commercially acceptable acetyl values that did not differ significantly among themselves nor from that of the acetate prepared from the same kind of commercial softwood sulphite pulp used for comparison in the previous acetylation tests.

Primary acetic acid gums or dopes obtained from the six aspen pulps were all higher in viscosity than that obtained from the control pulp. There was no significant difference in the viscosity of acetone solutions of the ripened cellulose acetates from the six pulps, and the intrinsic viscosity of these cellulose acetates was within the commercially acceptable range.

The filtrability of the cellulose acetates from all six of the aspen pulps was considered satisfactory, although the filtrability of only two was as good as that of the acetate obtained from the control pulp. These two were the cold-extracted sulphite pulp (bleach 2182, Table V) and one of the aspen sulphite pulps made at the industrial laboratory. The filtrability of the acetate made from the hot-extracted sulphite pulp (bleach 2195, Table V) was no worse than that obtainable from cotton linters on a comparable basis. The acetates from the hot-extracted, prehydrolysis-sulphate pulps (bleaches 2223 and 2232, Table V) had the poorest filtrability of the acetates produced from the four Forest Products Laboratory pulps.

Quality of the Cellulose Acetate Yarns. The cellulose acetate yarns obtained from the six aspen pulps did not differ significantly in tenacity and elongation among themselves nor from yarn made from the commercial softwood sulphite pulp.

‡ Spinning trials and interpretation of the results of these trials were made by Celanese Corp. of America, Central Research and Development Department, Summit, N. J.

Variations in delustering appeared related to process variables. Variations in response to dyeing appeared related in a normal way to variations in acetyl value. It is apparent that the haziness observed in the primary gums did not harm yarn quality.

SPECIFICATION FOR DISPERSE VISCOSITY

As mentioned previously, a minimum disperse viscosity for the experimental hardwood pulps had been recommended. This specification was based, necessarily, on experience with softwood sulphite pulp. The experimental pulps used in the spinning trials provided a range in disperse viscosity from 35% below to 60% above that of the softwood pulp with which they were compared. Since these aspen pulps were considered of industrially usable quality, it may be that disperse viscosity is not critical to the suitability of hardwood pulps in general for the manufacture of cellulose acetate yarn.

CONCLUSIONS

It is believed that with further study, conditions could be established for producing purified prehydrolysis-sulphate pulp from aspen of the quality now expected of sulphate pulp for the manufacture of viscose rayon tire cord.

Pulp suitable for the manufacture of cellulose acetate yarn can be made from aspen in different ways, including the use of the prehydrolysis-sulphate process. It is likely that similar results can be obtained with other hardwoods. Although the purified aspen pulps varied appreciably in those characteristics usually evaluated and gave primary acetic acid dopes high in haze, the cellulose acetate yarns obtained from them were all equal in quality to yarn made from a commercial softwood pulp of acetylation grade.

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A Preliminary Investigation of the Adaptability of the General Electric Puncture Tester to the Testing of Structural Insulation Board

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The General Electric Puncture Tester (GEPT) has been investigated as a possible means for testing the puncture resistance of insulation board. It has been provided with a special specimen holder which supports a specimen in a manner partially simulating the span involved in typical use of insulation board. In order that the testing of 25/32-in. sheathing might be encompassed, the scope of the GEPT has been extended to a new "Range 5." A detailed analysis of the energy effects in the puncture of insulation board by means of the GEPT equipped with the special specimen holder is presented. The energy expended by the device during a test is considered in two phases: phase 1 involves flexing of the specimen to the point at which local rupture commences in the small region immediately above the puncture head, and phase 2 is comprised of the processes of disruption and puncture. Materials for the experimental work were 1/2-in. building board, 1/2-in. tile board, and 25/32-in. sheathing, acquired on the open market and handled by code designation only. The mechanical behavior of the special specimen holder was satisfactory; it was found to be adequately rigid; its design was such that specimens were flexed and punctured without a single instance of failure by flexural breaking. Orientation of the machine direction of the board was found to be unimportant, and puncture data obtained with specimens firmly clamped along both the machine and cross machine pairs of edges, and along only the machine or cross machine pair of edges, show that it is immaterial whether only one pair of opposing edges or all four edges are firmly clamped. Puncture data obtained with the specimens lightly held against the specimen holder show that the effect of firm clamping (as compared with no clamping) is, if real, of the order of experimental uncertainty. In the testing of 40 specimens of 25/32-in. sheathing made by different manufacturers it was observed that the GEPT, operating on the new Range 5, successfully punctured 38 and almost completely punctured the remaining two specimens, thus suggesting that the new Range 5 should be appreciably augmented. The arm of the GEPT was equipped with an electric strain gage which, together with other electric and electronic equipment, permitted the presentation, on the screen of an oscilloscope, of the force-distance relationship during actual puncturing of insulation board. The oscilloscope traces for the puncturing of a large number of specimens of various types of insulation board were photographed, and the photographs were translated to force versus distance charts for analytical purposes. The results of the analyses of these charts are given. Microflash pictures, taken from below and above the specimens at different stages of the processes of flexing and puncturing, were obtained for the purposes of studying the kinds of failure of different types of insulation board, and for such analytical purposes as estimating the degree of flexure of the specimen and completeness of flexural return of the specimen after puncture. Data were also obtained on the degree of flexure of the puncture arm of the GEPT. The present study does not include an investigation of the significance of puncture data with regard to the use of insulation board.

Over the years, there has been a growing interest among the manufacturers of insulation board in the evaluation of the impact strength of their products. In introducing their recent work on the subject, Rowley and LaJoy (*1*) differentiated impact strength from failure under concentrated load, and discussed earlier methods for measuring the impact strength of materials. The methods covered in their review include the Charpy and Izod methods, the Bell Laboratories falling-ball test for fatigue endurance limits of plastics, other falling-ball and hammer tests, and the National Bureau of Standards falling-sandbag tests (used on built-up wall sections). In all these tests, excepting the Charpy and Izod methods, the falling object is released from successively increasing heights until failure is observed. In some of the methods, observations are also made on the "permanent set" after each impact. In some methods energy and, in others, height of fall is used to evaluate the impact strength. Rowley and LaJoy have developed a new apparatus which permits the dropping from any of various heights of an "indenter" designed specifically for the testing of insulation board. Rather than present a definite, arbitrary procedure for the testing of insulation board, these investigators obtained data relative to certain variables involved in the use of their apparatus, such as the influence, for a given height of drop, of the diameter of the indenter on the number of drops to failure. They also measured "permanent set," and obtained data on the resistance of various insulation boards to concentrated loads. The resistance to concentrated loads was measured by means of a special apparatus of their design. Both equipments involved the testing of specimens which were clamped only around the four edges, with no support behind the specimens in the region of impact or point of loading. Failure under concentrated loads was observed to be less dependent upon position of the point of loading than the impact strength.

Apart from the matter of the significance of impact testing to the ultimate use of insulation board, all the prior methods (excepting those of Charpy and Izod, which is not appropriately designed for the testing of

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insulation board) have in common at least two shortcomings: (1) they are impact *fatigue* tests, whereas it seems more likely that interest would center in a single impact strength test, and (2) from the viewpoint of production control testing, these methods are awkward and unduly time consuming.

The Celotex Corp. has raised question regarding the adaptability of the General Electric puncture tester (*2*, *3*) to the testing of impact strength of insulation board. The present work has been done in an attempt to study this question. The larger and more important question of whether puncture data are significant to the uses of insulation board should be the subject of future field and laboratory investigations. However, it is anticipated that some of the basic observations of the present work may be of value to a study of this second question. Early in World War II (1942), a detailed study of the Beach puncture tester was initiated on the APPA instrumentation program at The Institute of Paper Chemistry (*4*). The results of this study were made available to the General Electric Co. at about the time that organization was redesigning the puncture tester, and the suggestions made on the basis of the instrumentation study were incorporated in the new instrument. The new instrument has been described (*3*), and is now used extensively in the testing of paperboard. In view of the fact that important variables of the instrument have already been studied, it has not been deemed necessary for the scope of the present study to embrace more than an investigation of the adaptability of the General Electric puncture tester (GEPT) to the testing of structural insulation board.

BRIEF DESCRIPTION OF THE G.E. PUNCTURE TESTER

Detailed technical information relative to the GEPT should be obtained from the papers to which reference has already been made. For the reader who has already had occasion to study those articles, the following description of the GEPT will suffice to recall the salient features of the instrument. The GEPT perforates the specimen with a single blow of a trihedral point and registers the energy required to effect the puncture. As in various other devices, energy is stored in a compound pendulum which, in swinging, ruptures the specimen and indicates, by its final angular amplitude, the test result. The range of the GEPT may be varied by changing the mass of the compound pendulum and, in this way, at least four ranges may be obtained. The instrument is normally equipped with four scales which are graduated in special arbitrary units. *In the present study, the instrumental readings have been converted to inch-pounds.* The largest range extends to 1404 G.E. units. One G.E. unit is equivalent to 0.265 in.-lb., so that the maximum range of the normally equipped instrument is about 372 in.-lb. (For the purposes of visualization, this energy is equivalent to that of a 25-lb. body which has fallen through a vertical distance of 14 in.)

The trihedral puncture point is mounted on the end of a circular arm which follows an arc centering on the axis of the pendulum, and which passes freely through the specimen after the puncture. The puncture point, which is made of steel, has an altitude of 1 in. The point of the puncture head and the three edges formed by the intersection of the three impacting faces are not sharp, but have a radius of curvature of 0.050 in. A very light, triangular collar, which is attached to a trailing portion of the puncture head, imbeds itself in the hole formed by the puncture in the specimen and prevents the "ears" formed by the three lines of tear in the specimen from springing back upon the curved arm which carries the puncture head. This triangular collar provides friction-free passage of the arm through the perforation.

Figure 1, which shows the experimental layout employed in the present study, includes the GEPT (left rear background) in its normal location (one of two instruments) in the Container Laboratory of the Institute. It is mounted on a massive concrete base to prevent transfer of energy from the instrument pendulum to the instrument support.

ALTERATIONS OF THE INSTRUMENT

In order that the GEPT might be employed for the measurement of the puncture resistance of insulation board, it was necessary to design a new specimen holder and to create a new Range 5 for the evaluation of $^{25}/_{32}$-in. insulation board sheathing. The specimen holder with which the GEPT is normally equipped is quite satisfactory for the testing of heavy paperboard; however, the triangular opening in this holder is not sufficiently large to permit the testing of thick media. Furthermore, it was thought to be desirable to have some effect of span in the testing of insulation board in view of the fact that insulation board is normally nailed to studding.

The new specimen holder is shown in Fig. 2. It consists essentially of a very rigid steel frame, formed by welding together 0.5 by 1.5 in. mild steel bars. The outside dimensions of the frame and of the square-cut specimens are 13 by 13 in., and the frame forms a square opening which provides a span of 10.00 in. in either of the two principal directions. Since the puncturing blow is delivered from below, the specimen is placed on the lower side of the steel frame, and is held there by means of suitable clamps. Various clamping methods were to be studied in the present work, so that a clamp design of the sort which would normally be used in routine work was not evolved. Various lengths of channel iron and C-clamps were used to clamp specimens on all four edges, on either of the two pairs of opposing edges, and some data were obtained with no clamps at all.

In the normal use of insulation board, sheets are nailed to studding on 16-in. centers. The distance between a blow on a wall and the nearest line of support may be anything from zero to slightly more than 7 in. In the arrangement adopted for the present study, the blow is always at least 5 in. from the nearest line of support so that the span-effect is not greatly different from that encountered in the normal use of the board. An important aspect of the design of the specimen holder is that specimens of insulation board should fail only by puncture; in all the testing of insulation board of all classes involved in the present work with the holder depicted in Fig. 2, no specimen broke in flexural failure. Whether clamped or not clamped, the specimen always receives support along four edges of a square; if supported only at opposite edges (in the

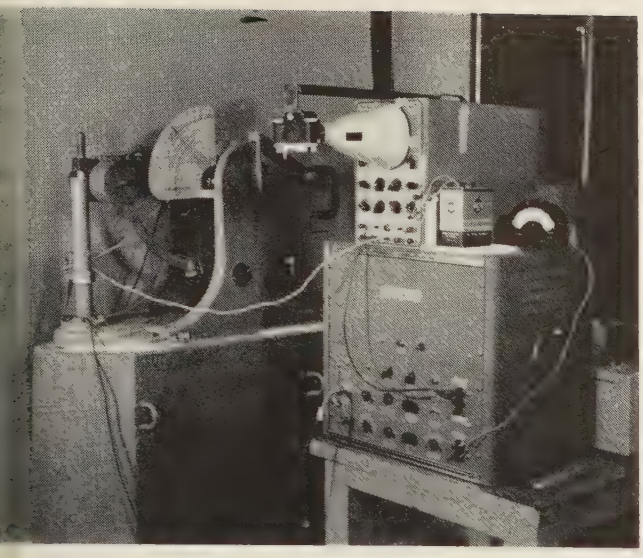

Fig. 1. Photograph of the equipment employed in the present study. The G.E. puncture tester is shown in the left background; electronic equipment employed for a force-distance study is shown in the right foreground

manner of a "simple beam"), it is very likely that most specimens of insulation board would fail in flexure rather than by perforation.

The extension of the range of the instrument is discussed in a later section of this paper.

THEORY

In considering the partitioning of the observed puncture energy, one is naturally led to a broad separation of the phenomena into two phases. Each of these phases may, in turn, be broken down for the purposes of discussion. During the first phase of energy expenditure, the specimen of board is flexed and the puncture head indents the board. The second phase of energy expenditure begins with the actual puncture of the board, and terminates when the edges of the triangular base of the puncture head move up and away from contact with the roughly triangular "ears" of the board that are formed during the puncturing process.

The First Phase (Primarily Elastic and Rheological)

Figure 3 presents a purely schematic representation, for discussional purposes only, of the variation of the force exerted by the puncture head with the vertical distance moved by the head after contacting the lower surface of the specimen. General experience in failure of materials suggests that the curve would, if ideally determined, display a fairly sharp discontinuity corresponding to the onset of rupture, such as that shown at B. We arbitrarily consider the first phase of the puncturing process to lie between O and B. The second phase, corresponding to actual breakthrough of the puncture head, lies between B and D; at C the puncture head completes the process of tearing the board, and the force falls to zero as the head rises above the last point of contact with the board (at D).

During the first phase, the energy expended by the instrument goes into bending the board and also indenting the specimen at the point of the puncture head. If the board were perfectly elastic (i.e., perfectly Hookean), this energy could be considered as strain energy. However, fibrous sheet materials are never Hookean; their load-elongation characteristic, whether for tension or flexure, curves away from a straight line such as OA (Fig. 3). Referring to the diagram, the increment Δy is the amount which the specimen yields beyond that displacement which would occur if the material obeyed Hooke's law. This extra yield is commonly referred to as creep or cold flow and is associated with the so-called rheological properties of the material. It depends upon the magnitude of the loading, the time schedule of the loading and, in flexural work, such factors concerning the test specimen as the specimen's shape and dimensions, orientation, temperature, and moisture content. The creep properties of a material such as insulation board are strongly time dependent, and phenomena associated with these properties, such as the load-deflection curve, are irreversible. Thus, if the load is reduced at any time prior to the point of rupture, the load-deflection curve would not be retraced, but would fall to the side of greater deflection, as shown by the dashed curve BG. The residual deflection, represented in Fig. 3 by OG, will diminish with the passage of time but, if the material has not previously been subjected to a mechanical conditioning procedure, the specimen will not return to its original shape even after an elapse of a great length of time.

The period of time for puncturing in the GEPT is only of the order of 0.02 sec., so that the flow phenomena described in the previous paragraph are not nearly as pronounced as in ordinary testing which latter involves time intervals of the order of 1000-fold greater than the foregoing estimate. Accordingly, it is not expected that the part of the characteristic which is associated with pure flexure will be strongly nonlinear. However, special tests with the GEPT set on a range that is insufficient to result in a break-through of a board specimen show that the indentation of the board by the puncture test point is quite appreciable. Such indentation would, therefore, be expected to account for a substantial portion (if not most) of the nonlinearity of the section OB.

The area lying under any portion of a load-elongation curve is equal to the energy expended by the agency

Fig. 2. Special specimen holder, for the testing of insulation board

supplying the loading force. Thus, the energy expended in flexing and indenting is equal to the area enclosed by OBEO. It will be appreciated that the quantity $F_1y_1/2$ is an approximation to this area, for this quantity is the area of the triangle OBE, which would be slightly less than the area lying under the curve OB. This approximation will be used for the purpose of discussing the influence of various factors upon the energy W_1 required to flex and indent the specimen. Thus, how might we expect W_1 to depend upon the span across the specimen mounting frame? We may begin this discussion with the smallest possible span (i.e., just large enough for rupture to occur, with room for the puncture head to pass through the specimen and space for the "ears" that are formed by the rupture). The deflection of the center of a specimen mounted upon a holder of short span will be small. Consequently, y_1 would then be small, and the work of flexure and indentation, W_1, would be at its minimum value. (This does not necessarily mean that the total energy required to produce rupture is at a minimum—see the later discussion.) As the span is increased, y_1 would become larger and it is expected that W_1 would be increased in nearly direct proportion to y_1. However, it is anticipated that an increase in the span would decrease the force F_1 corresponding to failure. For a given force upon the specimen exerted by the puncture head, a greater span will result in greater tensile stress near the top (convex) side of the specimen. This stress, which results from flexure of the specimen, is added to that which is produced by the puncture point near the top surface of the specimen in a region above the point. Accordingly, as the span is increased, the rupture force F_1 exerted by the puncture head should decrease. Thus, there are two opposing effects: as the span is increased, y_1 increases and F_1 decreases. Until data on these phenomena are obtained, it is not possible to say positively which effect predominates as the span is made larger, but it seems likely that the work of phase 1 would increase with increasing span.

What becomes of the energy W_1? As pointed out earlier, the load-deflection process is irreversible, so that not quite all of the energy is recoverable. The recoverable energy would be calculated from the area lying under the dashed curve BG. However, in order that recoverable work be expended by the specimen

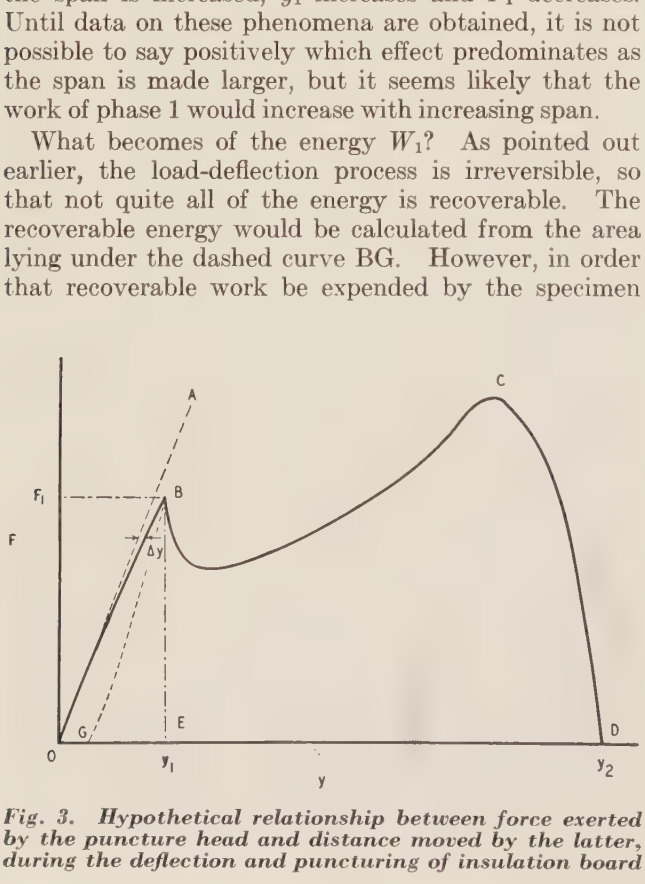

Fig. 3. Hypothetical relationship between force exerted by the puncture head and distance moved by the latter, during the deflection and puncturing of insulation board

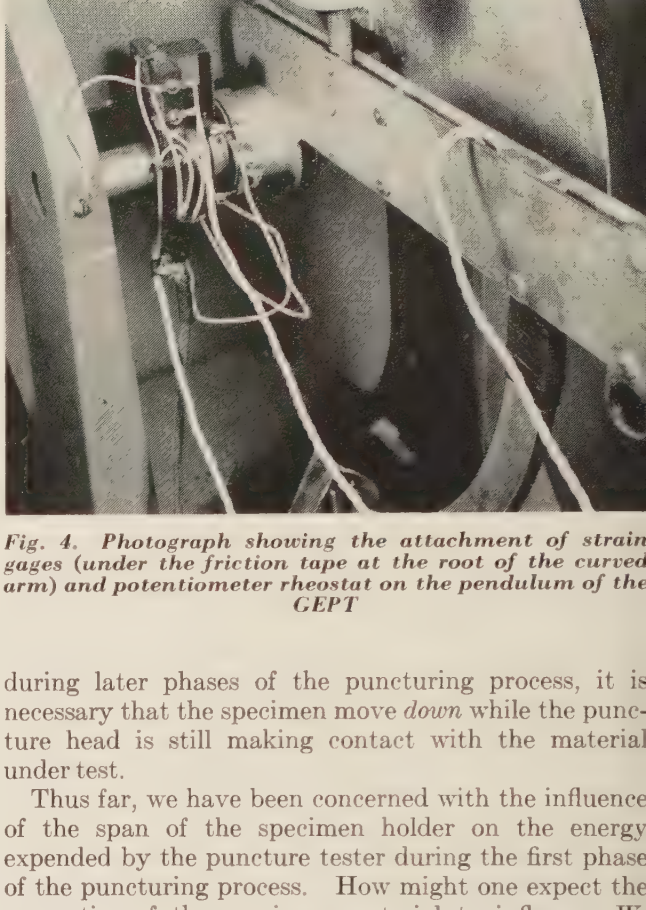

Fig. 4. Photograph showing the attachment of strain gages (under the friction tape at the root of the curved arm) and potentiometer rheostat on the pendulum of the GEPT

during later phases of the puncturing process, it is necessary that the specimen move *down* while the puncture head is still making contact with the material under test.

Thus far, we have been concerned with the influence of the span of the specimen holder on the energy expended by the puncture tester during the first phase of the puncturing process. How might one expect the properties of the specimen material to influence W_1 (for a given span)? In the approximate expression $F_1y_1/2$, F_1 is to be associated with the *ultimate strength* of the material and, of course, with the thickness of the board. For a given span length, the distance of movement of the puncture head prior to rupture, y_1 should depend upon the extensibility of the material. An increase in either one of these properties alone should result in an increase in W_1. It seems likely that the extensibility would have an influence upon F_1, as well as upon y_1 (the latter connection being direct). When a point enters the material, the magnitude of localized stress concentration—which, of course, is directly related to local failure of the material—depends upon the extensibility of the substance. For a given force exerted by the puncture head, greater extensibility should result in reduced stress concentration and greater resistance to break-through. It is seen, then, that any treatment which improves the extensibility of the material without undue reduction of the ultimate strength would be expected to increase the energy W_1 expended in phase 1. On proceeding in the opposite direction (toward lower extensibility and higher brittleness), the energy expended in phase 1 would be expected to decrease, unless the treatment resulted in a considerable increase in the ultimate strength. (For example, if y_1 were reduced 50%, the ultimate strength would have to be more than doubled to maintain W_1 unchanged.) In connection with this discussion of the influences of extensibility and ultimate strength, it should be recalled that, as a rule, increments in extensibility of cellulosic sheet materials are associated with decrements in stiffness (flexural); this rule is not an iron-clad one.

The Second Phase (*Rupturing*)

We now turn to a discussion of the factors that are expected to influence the energy W_2 expended in phase 2 of the puncturing process, which would be given by the area EBCDE.

On theoretical grounds it is to be expected that the work W_2 is a major portion of the total work expended by the instrument. A break in the curve at B, which we suppose involves a momentary drop in the load exerted by the specimen upon the puncture head, signals the onset of failure by break-through. As the head moves up through the board, its trihedral point produces three lines of failure, and the regions of the board between these lines are pushed up and deflectively bent to the side. In the testing of paperboard the "ears" thus formed are of roughly similar size, and the three lines of tearing are about 120° apart. In the testing of insulation board one observes very irregular ears and, occasionally, two or four ears are formed. Immediately after the break-through the ears grow rapidly in size as the processes of tearing and bending occur. The perimeter of contact between the board and the puncture head also increases rapidly and, associated with the growing region of failure, the force exerted by the puncture head increases. The tearing and bending continue until the edge of the triangular base of the puncture head attains the top surface of the specimen (which, in turn, has been elevated above its initial level by the flexure of the specimen). From this point on, the force exerted by the specimen on the puncture head is essentially that of rubbing friction between the ears and the edge of the base of the puncture head. This force falls to zero as the point of last contact with the ears is approached. The pendulum then swings freely to its final amplitude, at which point all the residual energy of the pendulum is in potential form, and the lazy hand of the instrument is left in the position over the instrumental scale giving the total energy expended by the device.

The energy W_2 expended by the instrument during phase 2 may be broken down into at least three categories: (1) Energy required to tear the board; this we may designate as W_{2t}. (2) Energy required disruptively to bend the ears or zones that are formed between the lines of tearing; this will be designated as W_{2b}. (3) Energy required to overcome frictional resistance between the puncture head and the specimen, from the point of first contact, through the processes of tearing and bending, to the last stage, in which the ears rub against the edge of the base of the point, as the latter rises up and away from the specimen; this will be designated as W_{2f}.

At this juncture we may observe that the work of phase 2 is $W_2 = W_{2t} + W_{2b} + W_{2f}$. Any further attempts to analyze these components of W_2 must necessarily be qualitative; but it is felt that a qualitative discussion will be helpful in improving our understanding of the puncture test and also in indicating future courses of investigation. Before entering upon this discussion, it should be remarked that there are interactions between at least two pairs of the three energy terms. If the work of tearing increases (all other factors remaining constant), the force between the puncture head and the specimen will increase and this, in turn, will result in an augmented frictional force and frictional work W_{2f}. Similarly, if the bending resistance of the board increases, there will be increases in both the frictional force and work. Thus, we may think of the frictional work as being a direct function of the tearing and bending works and also of the nature of the surfaces of the specimen (contacted side) and the puncture head.

The energy considerations in the tearing of fiberboard should be essentially the same as those which have been made in a theoretical discussion of the tearing strength of paper (*5*). In that discussion of the dissipation of energy in tearing, the work of producing the tear is divided into two portions—viz., that of rupturing fibers (which break instead of being pulled from the mesh of fibers) and that of dragging fibers intact from the mesh. In brief summary of the theory of tearing strength, we may present the simple formula on which much of the discussion of the influence of factors on tearing strength is based. If, in producing a tear, $(m + n)$ fibers are encountered (this number is considered to remain constant in spite of variations produced by changing conditions or treatment), we consider that m of the fibers are ruptured and n are pulled intact from the mesh of fibers. If the average energies required to rupture and to pull out fibers are, respectively, W_r and W_f, the energy that must be expended to produce the tear is $(mw_r + nw_f)$. It has been shown that the rupture work w_r should ordinarily be much less than the work w_f; this paradox is explained and illustrated in the cited discussion (*5*). Whether this is also true for typical insulation board depends upon the degree of fiber-to-fiber bonding and the tightness of the fiber mesh. The possibility that only a few of the individual fibers are ruptured when insulation board is torn should be kept in mind. If it should happen that one can neglect m in work with insulation board, then the analysis of the tearing strength of such boards would reduce to that of the energy nw_f—that is, to a consideration of the way in which various factors influence the energy associated with breaking fiber-to-fiber bonds and dragging fibers from the mesh. If this were the case, the expectation would be that an increment in fiber-to-fiber bonding (short of that degree of bonding which would result in rupture of a significant number of fibers) would result in *increased* tearing resistance. The reasons for this assertion are: (1) Each fiber makes contact with many other fiber elements and bonds exist at many of the points of contact. If the net effect of the many bonds per fiber is that the fiber may be pulled out of the mesh without rupturing, the fiber will nevertheless be extended, and energy must go into this process of extension. The many bonds (for a given fiber involved in the tearing process) are not all broken simultaneously, but undoubtedly fail in rapid-fire order; thus, the load-elongation characteristics of the fiber under consideration would be a complicated curve, displaying a number of points of discontinuity. We can be sure that strain energy delivered to the fiber in the act of tearing is not wholly recovered by the tearing process. Thus, as the intensity of bonding is increased (short of the degree resulting in rupture of the fiber) the work required to break the bonds increases (because the strain energy increases). Also, of course, the energy required to break the bonds *per se* increases. (2) Because of the

increased bonding, the fibrous structure will be denser and tighter and the work required to drag fibers from the mesh will be increased.

The foregoing discussion has been idealized in the interest of developing an understanding of the mechanically complex process which we designate as "tearing." Actually, of course, beating or other refining of the furnish produces fine fiber elements ("fibrillae"), some of which will be ruptured, even if whole fibers are not, so that an exact treatment of the subject would have to take this into account. Also, because of the fibrillation of fibers, the total number of fibrous elements involved in tearing does not remain constant at $(m + n)$, but the sum undoubtedly increases with increasing mechanical treatment.

In the above discussion we limited our supposed increments of bonding to that degree at which relatively few fibers would rupture. If, through the use of certain additives or intensive mechanical treatment such as beating and pressing, the intensity and number of fiber-to-fiber bonds were to be made sufficiently large that a significant amount of fiber rupturing occurs, then we should expect that the tearing strength of the board would commence to decrease, because the energy required to rupture a fiber is *less* than the drag work when the drag forces are not quite large enough for rupture to occur. In this event, W_{2t} would commence to decrease when the degree of bonding in the board exceeded a certain value. Thus, for example, we would expect W_{2t} for a given weight of hard, almost brittle board to be less than that for a less dense board of similar weight, provided that the degree of bonding in the latter board were not too low. On going from boards of low to high density, we would expect W_{2t} to display a maximum.

The drag work nw_f would increase with fiber length, if all other factors were to remain constant. Accordingly, we should expect the same dependence of W_{2t} on fiber length.

If the fiberboard contains an extremely viscous additive—so viscous that we might well describe the additive as being a nonbrittle solid—the presence of this additive would increase the drag work and, therefore, also the tearing work in puncture, W_{2t}. If, however, the viscosity were so high that, at the speed of puncturing involved in the GEPT, fibers were generally broken (instead of being generally pulled from the mesh intact), we would expect presence of the additive to decrease the term W_{2t}. Thus, for example, we should expect that, in the testing of the puncture resistance of an asphalt-impregnated board at various temperatures from quite high down to perhaps subzero values, the term W_{2t} would display a maximum. For temperatures above the optimum value, the viscosity of the asphalt would be low; for temperatures appreciably below the optimum, the board would be expected to break with brittle fracture.

In the equation for the work of phase 2, $W_2 = W_{2t} + W_{2b} + W_{2f}$, the second term on the right side is the work required to bend the "ears" of the board that are formed during the puncturing. If the specimen under test were a highly extensible material, this work would be essentially the strain energy stored in the bent ears. Such energy would not be recoverable by the puncturing process and would eventually be completely dissipated through various frictional effects to heat. However, in the testing of insulation board, only a portion of W_{2b} goes into strain energy because the bending of the board involves rupturing (including, in some instances, an apparent delaminating effect). The larger part of W_{2b} is associated with disruption of the board, and some of the energy for such disruption would come from the recoverable portion of the strain energy. In the testing of fiberboard with the GEPT, it therefore follows that some of the strain energy is involved in the disruptive phase of the bending of the ears. If W'_{2b} is the energy supplied to the ears of the specimen by the puncture head in nondisruptive bending, and if W''_{2b} is the energy of disruption, then the energy which the puncture head must supply is $(1 - j)\ W'_{2b} + W''_{2b}$ where j is the fraction of the energy supplied in pure bending that is recoverable to the process of disruptive bending. (In a hypothetical case in which virtually all the strain energy were recoverable to the fracture, $(1 - j) = 0$, and the energy W_{2b} would be completely the rupture energy, if the ears were bent to complete failure; if the ears were not bent to failure, the energy W_{2b} would be completely the strain energy and would depend upon the stiffness of the board, rather than upon the rupture work.) Thus, in the testing of fiberboards generally, the work W_{2b} should depend upon both the *stiffness* and the *rupture energy in bending*. All the insulation board specimens that have thus far been tested in the present work have exhibited bending fracture. This, combined with the quickness of the puncturing process (which should result in a relatively large value for j), leads one to believe that the work term W_{2b} is composed primarily of the bending *rupture energy* and only secondarily of the energy dissipated in internal friction within the specimen. *The work of disrupting a fibrous material in flexure, particularly when the material is in the form of thick board (thick as contrasted with paperboard), would appear to depend upon considerations very similar to those covered in our earlier discussion of the tearing work, W_{2t}.*

The energy dissipated in overcoming the frictional resistance between the puncture head and the specimen, W_{2f}, should depend, as mentioned earlier in this section, on the terms W_{2t} and W_{2b}. The frictional work should vary from essentially zero to increasingly higher values as $(W_{2t} + W_{2b})$ varies from zero to greater and greater values. The nature of the surfaces of the specimen and of the three upper faces of the puncture head point should have an important bearing on this relationship. If these surfaces are clean, smooth, and dry, the relationship would tend to be weak. However, kinetic friction depends upon more than loading and surface smoothness; in some instances, specific effects are observed on bringing two surfaces together—unusually large or small friction may be observed, even though the surfaces are smooth. Some of the manufactured insulation boards are coated with a film of asphalt. Although, in a popular sense, the asphalt surface is "solid," it actually should be classed as a fluid or, still more correctly, a rheological substance. There is no solid-to-solid contact in the ordinary sense, because the contacting faces of the puncture head carry a film of asphalt after completing the puncture. (No doubt if the testing were conducted at a very low temperature—e.g., $-40°$ F.—the viscosity of the asphalt would

be so enormous that the latter would act as an ordinary smooth solid; no asphalt would be transferred to the puncture head, and the friction might be relatively low.) On the other hand, the deliberate experimental application of a film of grease or graphite should lubricate the contact between the surface of a specimen and the puncture head and a lower puncture work should be observed. These phenomena were among those investigated in the previously referred to instrumentation investigation of the Beach puncture tester (*4*). Data on the effects of such surface treatment are given in Table VIII of that investigation for various paperboard samples. In all cases, the presence of asphalt very significantly increased the observed total energy of puncture; the average increment was 12.2%. Graphite and grease films caused small reductions in the GEPT readings, the average decrement being 6.0%. We may say that, for paperboards having puncture resistance covering a large range, the spread in instrumental readings associated only with differences in surface characteristics is of the order of at least 12%.

From the foregoing discussion we may conclude that the rupture work of phase 2 comprises the greater part of the energy expended by the GEPT in rupturing insulation board, and that this rupture work appears to depend primarily on the energy necessary to tear and rupture the fiberboard and, to a smaller extent, on the nature of the surfaces of the fiberboard and the puncture head. Some of the energy (probably a relatively small part) goes into elastic bending of the ears (strain energy) and, therefore, a portion of the observed instrumental reading will depend upon the stiffness of the board.

ILLUSTRATIVE DATA

Trial testing with the GEPT equipped with the special specimen holder was done with samples of $^1/_2$-in. building board, $^1/_2$-in. tile board, and $^{25}/_{32}$-in. sheathing. All materials employed in this study were purchased on the open market without comment to the vendors relative to the use of the material, and all samples have been assigned code numbers, the significance of which is known only to the Institute.

One bundle of building board of the production of each of six manufacturers was purchased and assigned code numbers. Each bundle contained six 4 by 8-ft by $^1/_2$-in. boards. Handling of the materials—especially when in the form of the large 4 by 8-ft. pieces—was done with great care, so that no weakening would be produced by undue stressing. Specimens 13 by 13 in. were cut from all the boards in each bundle, marked to indicate the long dimensions of the original board, and placed in racks in the 30% R.H., 73°F. preconditioning room of the Container Laboratory. After a preconditioning period of 5 days, the rack was wheeled into the 50% R.H., 73°F. room of the Container Laboratory, and the boards were allowed to condition an additional 6 days before testing. Sampling was arranged so that the several pieces tested for a given set of conditions were as representative of the bundle as possible.

Table I. Puncture of $^1/_2$-In. Wallboard, In.-Lb.

Code No.		1	2	3	4	5	6
Clamped 4 sides	Av.	114	117	137	188[a]	108	157
Parallel	S.E.	4.2	2.1	2.6	8.0	2.9	2.4
Range 3							
Clamped 2 sides	Av.	114	123	143	194[a]	110	150
Parallel	S.E.	2.6	1.6	1.9	2.9	1.6	3.7
Range 3							
Clamped 2 sides	Av.	112	123	138	190[a]	107	151
Perpendicular	S.E.	1.9	2.4	1.6	5.0	1.9	4.2
Range 3							
No clamps	Av.	125	127	159		105	159
Parallel	S.E.	3.2	3.2	5.3		3.7	3.4
Range 3							
No clamps	Av.	133	131	147	199		170
Parallel	S.E.	3.7	3.2	8.0	5.8		1.9
Range 4							

[a] These readings were taken on Range 4.

A specimen under test is clamped to the under face of the specimen holder with the factory-finished side facing down, so that this side will be struck by the point of the puncture tester. The elevation of the specimen relative to the apparatus is such that the puncture point strikes the specimen at nearly perpendicular incidence. The sample may be clamped at all edges, at two opposing edges, or simply be lightly supported in contact with the steel frame. All these possibilities have been investigated in the present work.

The average results for the several conditions of clamping and orientation are presented in Table I.

The first column of Table I presents the condition of clamping and orientation of the specimen. The designations "parallel" and "perpendicular" refer to the orientations in which, respectively, the originally long direction of the board is parallel or perpendicular to the plane of swing of the pendulum of the GEPT. Whenever a specimen was clamped on two sides only, the clamped sides were those parallel to the plane of swing of the pendulum. Where no clamps were employed, the specimen was held in light contact with the special specimen holder by means of clips made from heavy wire. (These clips furnished no significant bending moment at the edges of the specimen but served only to support the specimen against the lower face of the specimen holder.) Each result given in Table I is the average of observations on five specimens, and the figure given immediately below each average is the standard error (expressed in inch-pounds).

A study of the data of Table I shows that there is no real difference between the results of testing with the conditions of the first three rows; that is, so long as the specimens are clamped to the frames, it does not matter whether they are clamped on only two sides, on all four sides, or whether the originally long direction of the parent board is parallel or perpendicular to the plane of the swing.

However, there may be a small clamping effect. The results obtained with no clamping of the specimens were higher in all cases but one and, with this one exception, the increase in impact energy associated with free suspension of the specimen is of the order of two or three times the standard errors of the differences. Some of the energy of puncturing goes into the nonrecoverable energy of flexing the specimen (see section on theory). When a specimen is not clamped, the magnitude of flexure should be greater and one would, accordingly, expect a higher test result for this condition. With the one exception of sample 5, the results appear to bear this out.

It will be noticed that it was possible to test four of the samples on two ranges of the GEPT. No clamps

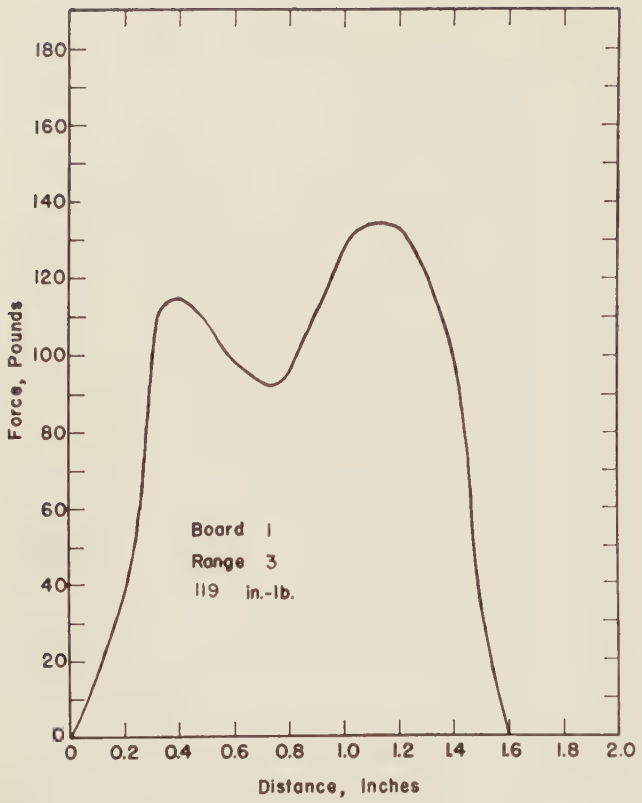

Fig. 5. The average force-distance relationship for board 1 (a 1/2-in. building board)

were used, so that the results given in the last row of the table should be compared only with the data presented in the next to last row. Although the data obtained with Range 4 were slightly greater in three out of the four cases, statistical consideration of the data does not warrant the conclusion that the differences between the results obtained with the two ranges are real. The decision as to whether there may be a small, systematic error between the two ranges, when the GEPT is applied to the testing of insulation board, should rest on observations with many more specimens than were employed in the present work.

Two boxes of 1/2-in. tile board of the production of each of four manufacturers were purchased on the open market. Specimens from each of a pair of boxes representing a given product were tested separately, so that a crude measure could be obtained of sample-to-sample variation. All the specimens were preconditioned in a room maintained at 30% R.H. and 73°F. At the end of 3 days of preconditioning, the specimens were moved to the main laboratory of the Container Section, which

Table II. Puncture of 1/2-In. Tile Board, In.-Lb.

Code No.	Clamped 2 sides Av.	S.E.	Not clamped Av.	S.E.
7a	137	4.2	140	3.3
7b	110	1.3	114	2.1
7a and 7b	123	5.0	127	4.8
8a	149	5.0	162	3.0
8b	151	3.1	157	1.9
8a and 8b	150	2.8	160	1.9
9a	152	4.0	146	3.9
9b	147	4.2	156	4.2
9a and 9b	149	2.9	151	3.2
10a	147	6.7	164	5.1
10b	125	2.1	141	2.9
10a and 10b	136	4.1	154	4.8

Table III. Puncture of 25/32-In. Sheathing, In.-Lb.

Code No.	Clamped 2 sides Av.	S.E.	Not clamped Av.	S.E.
11	272	8.8	272	3.2
12	247	7.5	274	6.7
13	349	10.8	369	13.2
14	392(?)	8.6	390	3.7

is maintained at 50% R.H. and 73°F., where the specimens were conditioned for 9 days prior to testing.

In view of the very small differences observed between the instrumental readings when the 1/2-in. building board was punctured "in" and "across" the long direction of the original board, no attempt was made to orient the specimen in either of the two principal directions. Impact was on the finished side. One half of the specimens tested were rigidly clamped along the two edges parallel to the plane of swing, and the other half of the specimens were not clamped, but merely held in place with the wire clips. All readings were taken on Range 3 of the GEPT. The results obtained are presented in Table II.

The letters "a" and "b" distinguish between the two boxes of each product. Thus, for example, it is clearly evident that the material of box 7a had substantially greater puncture resistance than that from box 7b. Each average and standard error is for five determinations except that, where the specimens of tile board from two boxes of each type were considered together, the average and standard are for ten determinations, and the standard error, which is expressed in inch-pounds, for the combined results includes the effect of variability between boxes. In general, the

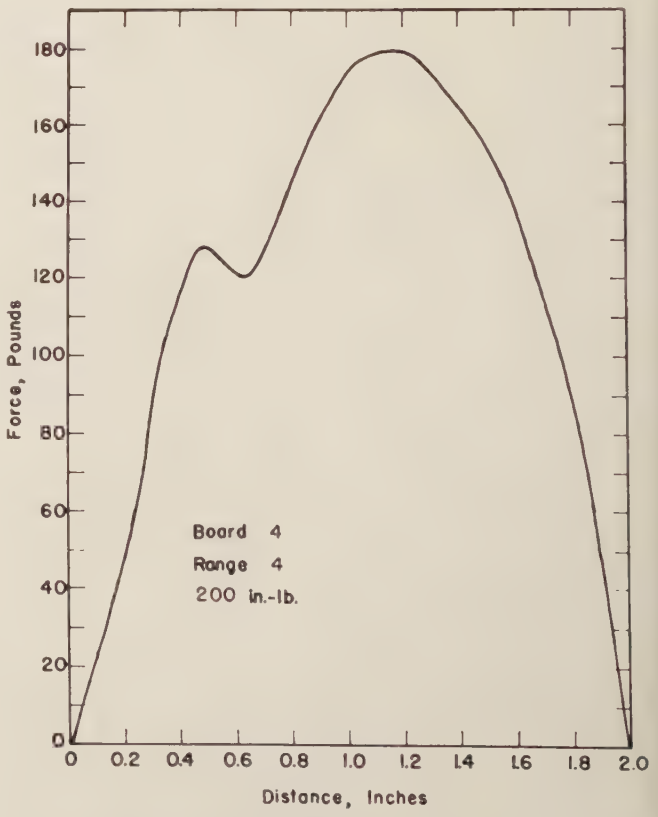

Fig. 6. The average force-distance relationship for board 4, illustrating a large tearing force (a 1/2-in. building board)

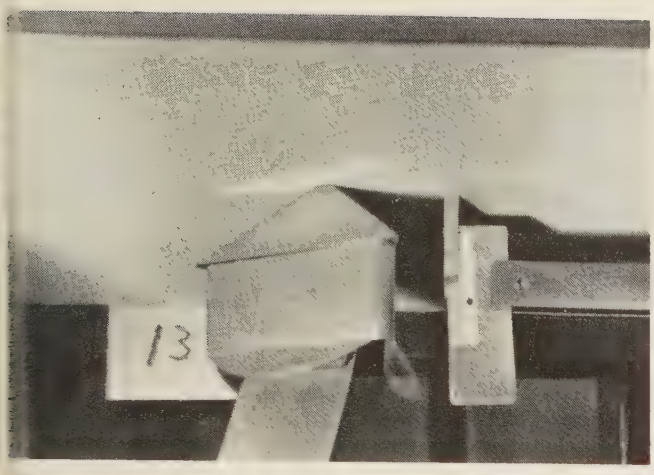

Fig. 7. This and the remaining figures are microflash pictures of $^1/_2$-in. building board specimens (all from the same sample), taken at various stages of the processes of indentation, flexure, and rupture of the board

standard errors appear to be satisfactorily small, and there is no indication that instrumental precision is not all that could be desired.

The results for any one sample failed to show any statistically real difference between clamping and not clamping the specimens to the specimen holder; however, the impression gained from all the results is that the puncture resistance may be slightly greater when the specimens are not clamped, in agreement with the results for the $^1/_2$-in. building board.

In general, puncture produced three "ears." Boards 8a, 9a, and 9b showed more tendency to produce two-eared punctures, however. Board 9 showed rather irregular punctures; in the testing of some of the specimens of this material, the ears were actually perpendicular to the faces of the puncture head.

When the puncture of the $^{25}/_{32}$-in. sheathing was attempted, it was discovered that Range 4 of the GEPT was insufficient for complete puncturing of the material. Range 4 is obtained by adding instrumental weights "A," "B," and "C" to the pendulum. On removing the "A" and "B" weights and replacing them with the "C" weight from another GEPT (thus providing two "C" weights), these boards could be tested. A new "Range 5" was thus formed and calculations were made for the purpose of converting readings from the scale of Range 4 to Range 5.*

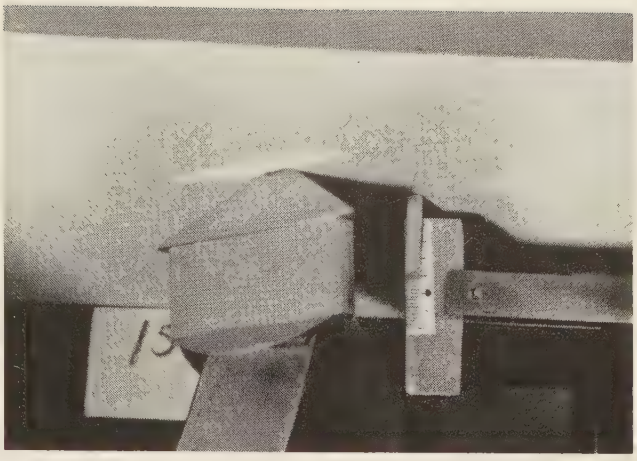

Fig. 9

One bundle of $^{25}/_{32}$-in. sheathing was purchased on the open market from the line of each of four manufacturers. After cutting to 13 by 13-in. squares, the specimens were preconditioned in a room maintained at 30% R.H. and 73° F. for a period of 3 days, following which the specimens were moved to the main laboratory of the Container Section where they were tested after 9 days of conditioning at 50% R.H. and 73°F.

Using the new Range 5, the data presented in Table III were obtained for the $^{25}/_{32}$-in. sheathing. Each average and standard error is for the testing of five individual specimens. The clamping, and supporting of specimens without clamping, were done as in the testing of the $^1/_2$-in. tile board. In the testing of board 14, when clamped on two sides, the puncture head did not quite break free from the ears of the puncture, so that maximum scale readings were arbitrarily assumed in arriving at the questioned average given in Table III.

Again, it will be seen that there is some suggestion of a clamping effect, because in three out of four cases the results obtained without clamping were the larger.

The ears formed in board 11 appeared to break and crumble as units, whereas the ears of boards 13 and 14 seemed to delaminate as they were bent upward. There appeared to be a general tendency for the ear formed by the puncture head face farthest from the axis of rotation to be somewhat larger in size than the other two ears. Although three ears were formed in

* As discussed later, a new range formed in this way is inadequate.

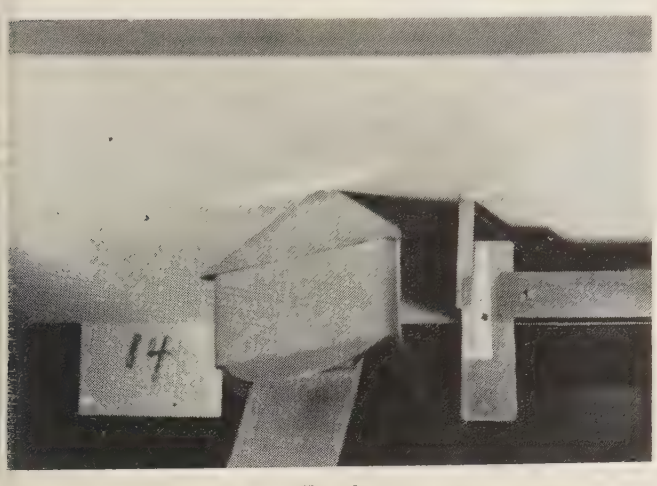

Fig. 8

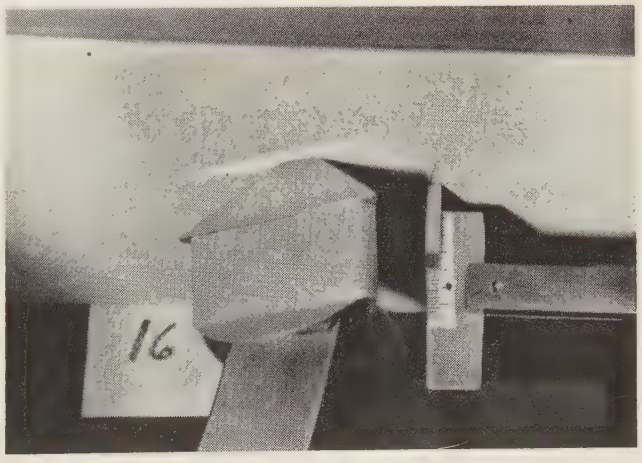

Fig. 10

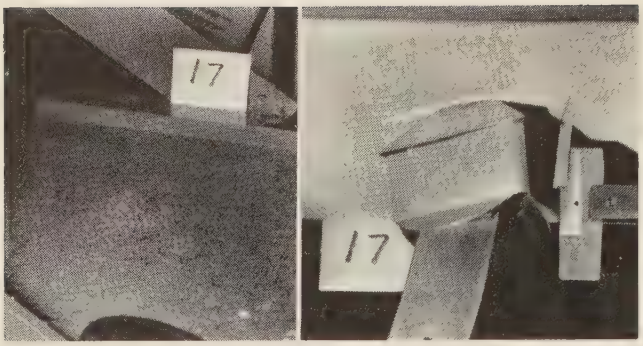

Fig. 11

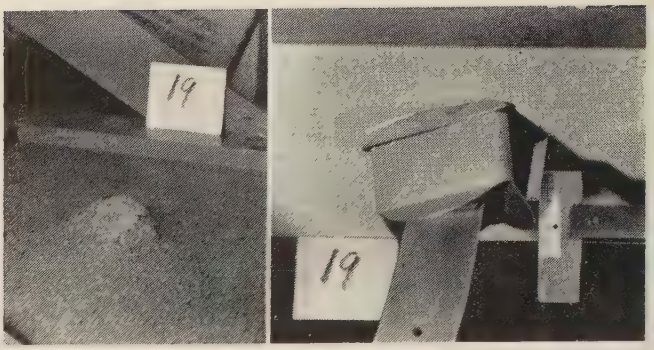

Fig. 13

all other cases, boards 12 and 14, when punctured without clamping, sometimes exhibited a formation of four ears.

The collar which follows the puncture head and is intended to restrain the ears from contacting the puncture head arm behaves properly in testing the building board and tile board, but in no instance did it enter more than half way into the sheathing. In the testing of board 11, it entered about one third of the way and immediately popped back out.

One of the boards was coated with asphalt, some of which was transferred to the puncture head as the puncture was made. The head, therefore, was cleaned with a solvent after each puncture.

As a general conclusion, it may be said that the puncture tester has performed satisfactorily in the testing of all types of insulation board thus far tested, with the possible exception of sheathing. In the testing of sheathing, the range must be augmented as described, and the "ear-holding collar" should be modified to operate satisfactorily. It is evident that the new Range 5 is not sufficiently energetic for the general testing of insulation board sheathing and, hence, a new range is suggested which is appreciably more energetic than the Range 5 involved in the present work.

THE FORCE-DISTANCE RELATIONSHIP DURING PUNCTURE OF INSULATION BOARD

The auxiliary electronic equipment shown in Fig. 1 was employed for the purpose of obtaining the variation of force on the puncture head of the GEPT with distance (absolute) moved by the puncture point during the complete process of flexing and indenting of the specimen and break-through, tearing, and complete perforation of the material. The use of the electronic equipment for the determination of the force-distance relationship was projected purely for research purposes, and it should not be inferred that such equipment is suggested as an adjunct to the normal use of the GEPT.

A measure of the force exerted by the puncture head was obtained through the use of bonded-wire electric strain gages mounted upon the puncture arm, at a point near the root of the arm. One Baldwin type A-1 gage was cemented to the top surface of the puncture arm, and another one was cemented to the bottom surface, in a push-pull arrangement. They were covered with a protective wrapping of friction tape which may be seen at the right in Fig. 4. The strain gages were placed in a simple bridge arrangement, the output of which was connected to a special d.c. amplifier, whose output was, in turn, fed to the vertical deflection circuit of an oscilloscope.

A horizontal deflection on the oscilloscope screen, which would be proportional to the motion of the puncture head, was obtained by means of a circular-type potentiometer rheostat which was removed from its housing and connected to a hub of the pendulum, with its center on the axis of rotation. A stationary contact arm was then so mounted as to wipe against the potentiometer winding. This arrangement may be seen in the upper left portion of Fig. 4. The section of the potentiometer which was in contact with the wiper arm until just before the puncture head contacted a specimen was electrically shorted out so that the sweep would not start unnecessarily early. A 22.5-v. battery was connected across the potentiometer rheostat, and the contacting arm was connected to the horizontal deflection circuit of the previously mentioned oscilloscope.

In order to obtain a photographic record of the trace produced on the oscilloscope screen a special mount was constructed to hold a Leica 35-mm. camera (equipped

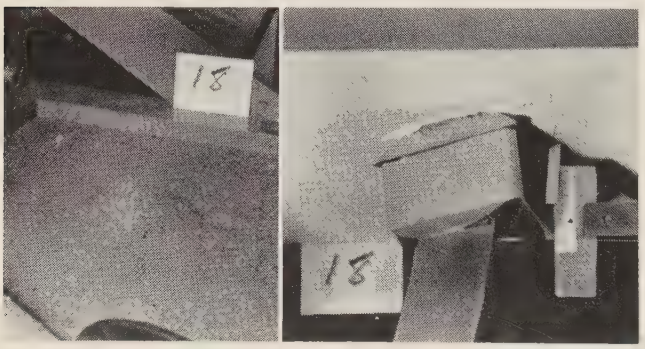

Fig. 12

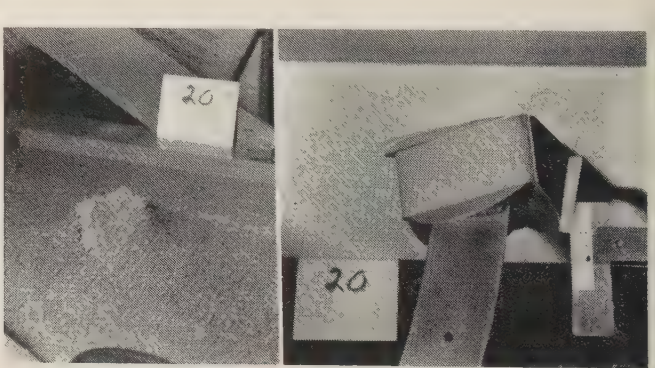

Fig. 14

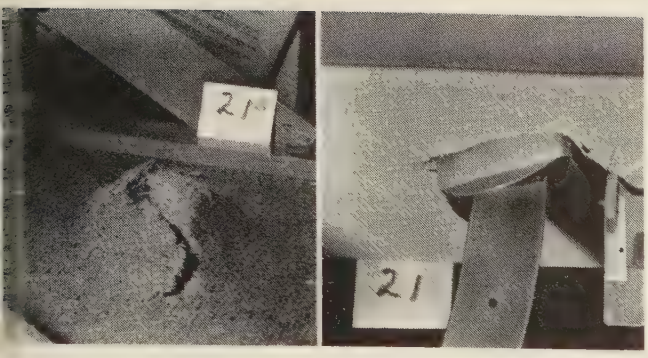

Fig. 15

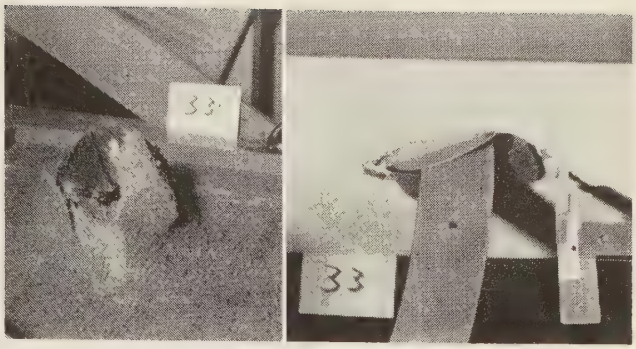

Fig. 17

th copying attachments) in proper orientation in front of the screen. A light shield lined with black velour paper excluded room light. This photographic arrangement is included in Fig. 1.

Calibration of the x and y axes on the oscilloscope screen could not readily be done with high accuracy, nor was it felt necessary to obtain good accuracy in view of the fact that the recordings were to be used primarily for studying the relative importance of the various phenomena discussed in the section on theory. It is believed, however, that the recordings obtained for the various specimens were on common scales. Calibration of the x-axis (distance moved by the head after contacting the specimen) was accomplished by fastening a short brass rod through an existing hole in the puncture arm just back of the puncture head, so that it successively contacted two lengths of piano wire (mounted on but insulated from the frame of the tester) as the pendulum swung through that portion of its arc in which it normally punctured the board. By means of a dry cell and suitable electrical connections, two "pips" were made to appear on the oscilloscope horizontal trace when the pendulum was released. To find the actual distance represented by the distance between the pips, measurements were made of the actual distance of motion of the puncture head from electrical contact with the first contactor to the second contactor.

The y-axis (on which force is recorded) was calibrated in the following manner. An old puncture head was attached to the puncture arm and allowed to strike a tempered steel beam, which was tied loosely to the lower face of the specimen-holding frame ("simple beam" mounting). As a photograph of the oscilloscope trace was taken, the actual deflection of the steel beam was measured. A load-deflection curve for the beam, as supported on the specimen-holding frame, was obtained with the Baldwin Universal testing machine. It was then possible to determine what force was represented by a given vertical displacement on the calibration photographs. During the period of work a variation of about 6% was observed in this relationship. However, inertial effects would cause a hidden error which would not appear in such a numerical expression of reproducibility.

Calibration runs were made at the beginning and end of each series of runs. Drift during a testing period was always found to be negligible. All test specimens were clamped on two sides parallel to the swing of the pendulum, and all specimens were placed in the specimen holder with the finished side down, so that this side would be struck by the puncture head.

Five or ten oscillograms were obtained for each of the eighteen samples (the two boxes of $^1/_2$-in. tile board from each of four manufacturers were regarded as different samples). The oscillograms, which were on 35-mm. film, were read by placing the film in a microfilm reader, the screen of which was equipped with a transparent grid which had been constructed in accordance with the calibration, so that values of force and distance could be read directly from the enlarged image on the grid. An average force-distance curve was then constructed for each sample.

The force-distance curve obtained for the first board tested (sample 1) proved to be typical of the curves for nearly all the samples and is given in Fig. 5 for illustrative purposes. It will be seen that the shape of the curve is approximately in agreement with the theoretical expectations (Fig. 3). The curvature of the initial rise of the curve, concave up instead of concave down, might be explained by a combination of increasing resistance to indentation and inertial effects. The first

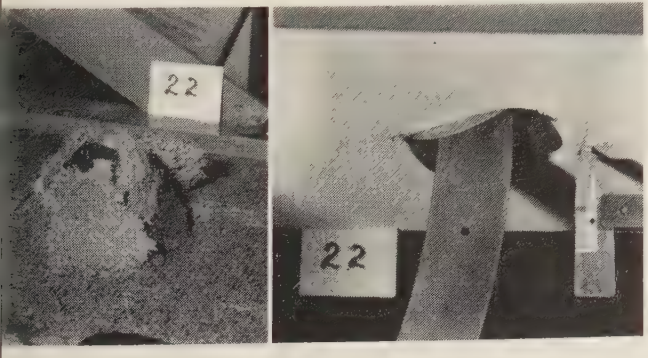

Fig. 16

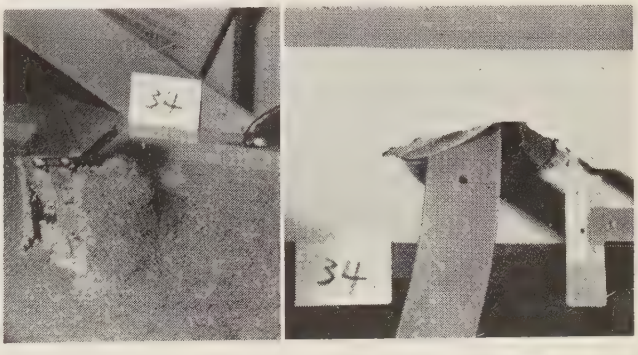

Fig. 18

peak is rounded instead of sharp, which is clearly the result of inertial effects; as discussed earlier in the section on theory, this peak should actually be quite sharp. In accord with expectations, the greater part of the energy of the puncturing process is that of tearing, bending, and breaking of the "ears."

The curves for four $^1/_2$-in. building boards and two samples of $^{25}/_{32}$-in. sheathing were taken at random for planimetric determinations of energy. The area under a force-distance curve should be equal to the reading of the GEPT. The ratios of the planimetrically determined energies to the GEPT readings were found to be 1.19, 1.21, 1.24, 1.19, 1.31, and 1.26, for these six samples. This is fair agreement in view of the previously mentioned errors of calibration. Of greater interest from the viewpoint of the present study is the fact that these values display a standard deviation of only 4%, part of which is, of course, attributable to sample variability. It should be mentioned again that the force-distance curves were obtained for the purpose of studying how the energy delivered by the instrument is partitioned among the various effects, rather than to check the instrument or to serve as an adjunct to the normal use of the instrument.

The greatest deviation from typical force-distance curves is that shown in Fig. 6, for a sample of $^1/_2$-in. building board which evidently resists puncture with an unusually large tearing force.

A study of all the force-distance curves leads to the following principal conclusions:

1. The force-distance relationship generally displays two maxima for building board, tile board, and sheathing. The first of these peaks corresponds to the initiation of rupture and the second is associated with the build-up and decay of force during the tearing and bending of the board in the zone of rupture.

2. The fraction of the instrumental reading of energy which is involved in bending the specimen and indenting the material to the point of rupture may be estimated by considering the ratio of the energy lying under the curve from the beginning of the curve to the first peak, to the total area lying under the curve. As an illustration, we consider board 1 (Fig. 5). The fracture of the total area which lies under the curve between 0 and 0.4 in. is 0.14. That is to say, 14% of the instrumental indication of 119 in.-lb., or 16.7 in.-lb., is involved in deforming the specimen to the point of rupture. The remaining 102 in.-lb. is the work of *rupturing* including the energies of tearing, bending, and frictional contact between the puncture head and the specimen. However, as discussed earlier, an appreciable fraction of the 16.7 in.-lb. may have been transferred to the rupturing of the board, so that the energy ultimately going into rupture would lie between 102 and 119 in.-lb.

MICROFLASH PICTURES OF G.E. PUNCTURE

It was felt desirable to obtain certain qualitative information regarding the nature of the puncture of building board by the GEPT. For example, how much is the test specimen deflected when supported by the special specimen holder? This relates to the amount of energy which is consumed initially merely in bending the specimen. What is the appearance of the specimen, as seen both from below and above, at various stages of puncture? How far, at least roughly, must the puncture point enter the board before there is photographic indication of failure on the back (top) side of the specimen? Following the puncture, does the test specimen return to its original position without oscillation, or does the strain energy dissipate itself through oscillation of the specimen? This last question relates partly to the outcome of the energy given by the instrument in the bending of the specimen.

In an attempt to answer these questions, and to obtain photographic information which might be of general usefulness, equipment was set up for the taking of microflash pictures.

Illumination for taking the pictures was provided by discharging a 40-mfd. condenser charged to 2000 volts through a Sylvania Type R4330 flash lamp. This lamp is of the "trigger" type—that is, the flash is initiated by applying a high-voltage pulse to the tube. In the work reported herein, the triggering was accomplished by discharging an 8-mfd. condenser charged to 90 v. through the primary of a Model T Ford spark coil, the secondary coil of which was connected to the trigger electrode of the flash lamp. The Ford coil was modified to produce a single pulse by blocking open the vibrator contact and electrically connecting the trigger switch (located in the GEPT) at this point.

In order that the operator could control the instant at which the picture could be taken, the potentiometer which had been used for obtaining pendulum movement in the force-distance determinations was removed. A spring-steel wire was mounted on the pendulum and a steel bar on the insulating holder was attached to the frame. By turning the insulating holder around the axis of the pendulum, it was possible to adjust the point at which the wire and bar made contact, and triggered the flash.

A series of pictures of both the top and bottom surfaces of three different boards were made to show how the boards behaved at various stages of puncture. Since only one picture could be made for each puncture, each picture shows a puncture of a different specimen. The boards, however, were chosen for similarity of puncture from specimen to specimen on the basis of the force-distance diagrams obtained earlier.

For the purposes of illustration, only one series of photographs is presented herein in Figs. 7–18.

In order that estimates could be made of the deflection of the test specimens, a strip of aluminum foil was cemented to the lower surface of each board specimen. This small strip of aluminum foil served as an index, the lower end of which showed the deflection of the specimen by its position over a rigidly mounted scale. This arrangement may be seen in the shots taken from below in Figs. 7–18. In each case, the scale was adjusted so that the lower end of the aluminum strip was on the line marked with a solid 0 when the specimen was in its initial, undeflected position. Each small division on the scale is 1 mm. or about 0.04 in.

Study of the microflash pictures shows that, as a rule, appreciable indentation of the lower face of the specimen occurs before there is evidence of disruption of the specimen, as seen from above. The deflection of a specimen (for the clamping arrangement used in the present study) is maximum when the puncture head is part way through the specimen and extensive rupture has commenced to occur. It is interesting to note

that the deflection begins to decrease substantially before the puncture head has completed the perforation and returns almost to zero before the puncture head separates from its last contact with the "ears" formed by the rupture. This leads to the interesting conclusion that a substantial fraction of the strain energy stored in the specimen during the initial flexing of the material is returned to the process of puncture. As previously discussed, a portion of this strain energy is lost in overcoming internal friction within the material. None of the photographs taken in the last stages of the puncturing process revealed any evidence of oscillation of the specimen, which means that, of the original strain energy, virtually none is left in the form of oscillation of the material. In all cases, the specimens exhibited a residual deflection from their original positions of roughly 1 mm. It seems reasonable to suppose, therefore, that most of the energy going into strain energy during the initial deflection of the specimen is returned to the later phases of the puncturing process.

DISTORTION OF THE PUNCTURE ARM

The deflection of the puncture arm was determined for the radial direction by means similar to those employed in the instrumentation study of the early form of the puncture tester (*4*, *5*). The collar below the puncture head was removed from the arm and a length of spring-steel wire was attached to the arm a short distance behind the puncture head. This wire was soldered to a thin sheet of brass so that it could move horizontally but could not vibrate parallel to the plane of swing. A microscope slide, covered with soot from burning camphor, was fastened in place of the board deflection scale. Then, as the pendulum swung, the wire traced a mark on the sooted surface. Two traces were made on each slide: one with no specimen in place, and the other during an actual puncture of board. Thus, the difference between the curved traces provided a direct measure of a radial deflection of the arm. Four boards were punctured: samples 1, 4, 7b, and 13. The distortion of the arm was found in this way to be of the order of $^1/_{16}$ in. or less in the testing of $^1/_2$-in. wallboard and tile board, and of the order of $^1/_8$ in. in the testing of insulation board sheathing. The strain energy stored in the arm during the early part of the puncturing process is estimated to be of the order of magnitude of 5% of the instrumental reading. In view of the probability that a substantial portion of the strain energy is returned to the process of puncture, it is concluded that the strain energy error is not of much consequence, particularly when it is considered that it is of similar order of magnitude in the testing of boards of similar kind.

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Routine Determination of Lignin in Semichemical Pulps by a Modified Tingle Procedure

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Direct methods of lignin determination are too time-consuming to be practical for mill control use. For this reason, most routine "hardness" or bleachability tests employ indirect methods. The most widely used of these, the permanganate number, was shown to be inapplicable to semichemical pulps. Inability of the permanganate to penetrate the fiber bundles and shives in the pulp resulted in permanganate numbers that could not be correlated with the lignin content of the pulp. It was found that treatment of the pulp sample with a 9:1 mixture of hydrochloric and sulphuric acids (as employed in the Tingle bromine absorption method) swelled and partially dissolved the cellulose, thus rendering the lignin more accessible. Subsequent addition of hypochlorite afforded a chlorine bleachability test which rivaled the permanganate method in speed and simplicity. Good linear correlation between TAPPI lignin content and chlorine consumed was obtained for neutral sulphite semichemical aspen pulps having lignin contents ranging from 12 to 17%.

Quantitative estimation of the lignin content of the pulp is a very important control test in most pulp mills. Since lignin removal is a primary aim of the cooking process, the lignin content of the unbleached pulp is a reliable index of the degree of cooking. Similarly, the lignin content of the pulp is a good indication of its expected bleach demand, or bleachability.

Direct methods of lignin determination, such as TAPPI Standard T 222 m-50 (*1*), are frequently too time-consuming for use in mill control work. For this reason, indirect methods are generally employed in the pulp mill. Those indirect lignin methods most suitable for control purposes are based upon the relative ease of oxidation of the lignin and the relative stability toward oxidizing agents of the remainder of the pulp constituents.

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The two indirect lignin methods most widely used are the Roe chlorine number and the permanganate number. The chlorine number method [e.g., TAPPI Standard T 202 m-45 (*1*)] requires more complicated apparatus and lacks the ease and simplicity of the permanganate method. The latter method, as typified by TAPPI Standard T 214 m-50 (*1*), therefore enjoys the greater popularity.

These methods have proved generally satisfactory when applied to fully cooked chemical pulps. However, they often fail to yield useful results when applied to semichemical pulps. Of the two methods mentioned above, the Roe chlorine number apparently can be successfully applied to hardwood semichemical pulps (*2*). The permanganate number, however, was experimentally found to be unsuitable for determining the bleachability of semichemical pulps, although the precision of the method was excellent. Therefore, attention has been directed toward other methods.

EXPERIMENTAL WORK

Considerable exploratory work has been carried out for the purpose of developing some method for the evaluation of lignin in highly lignified or semichemical pulps, since it is believed that such a method will have considerable general utility.

Some consideration was given to a direct lignin determination according to the method of Noll (*3*). Hydrolysis of the pulp is accelerated by the use of 78% sulphuric acid with dimethylaniline as a catalyst, and the lignin can be filtered off within a few minutes. However, drying and weighing of the lignin are necessary; therefore, the method is not desirable for control purposes. In addition, it has been observed that small kernels of the pulp sometimes remain undisintegrated.

Apparently the rapid hydrolysis obtained in the Noll method is caused by the increased temperature resulting from the reaction of the dimethylaniline and the sulphuric acid, rather than to any catalytic action of the amine. This higher temperature of hydrolysis leads to some carmelization of the polysaccharide material, and results in yields of lignin which are too high in comparison with customary methods such as the TAPPI Standard (*1*).

The permanganate number method fails badly with pulps of high lignin contents. In a series of hardwood pulps representing increasingly less drastic cooking (increasing lignin content), it has been found that the permanganate number levels off with very raw pulps and even decreases as the series approaches the original unpulped wood.

Table I. Relationship of Permanganate Number to N.S.S.C. Pulp Coarseness

Permanganate No.	*Pulp coarseness, % retained on 20-mesh Bauer-McNett screen*	*Lignin content, %*
39.4	41.9	13.92
39.7	42.2	12.25
40.4	38.5	15.24
43.0	41.1	14.82
43.4	30.4	15.34
44.2	39.7	14.58
44.8	34.8	14.63
45.4	44.7	15.89
46.1	35.4	13.16

A number of analyses showed the lack of correlation between permanganate number and lignin content for a series of neutral sodium sulphite semichemical (N.S.S.C.) pulps made from unpeeled aspen wood. Lignin contents were determined according to TAPPI Standard T 222 m-50 and permanganate numbers according to TAPPI Standard T 214 m-50, modified to use 25 ml. of 0.25 *N* potassium permanganate.

It seems probable that the defect in the permanganate method lies in the inability of the permanganate ion to penetrate the shives and fiber bundles of the pulps. Statistical examination of the data of Table I supported this conclusion.

Partial correlation coefficients for these data indicated that, at a constant lignin content, the permanganate number was inversely related to the coarseness of the pulp. At a constant coarseness, the permanganate number was directly related to lignin content, as expected. Lignin content was independent of pulp coarseness.

From this information, it is evident that a bleachability test for semichemical pulps requires a method of sample preparation that will render the lignin more accessible to the oxidizing agent or an oxidizing agent that is better able to penetrate the fiber bundles than is permanganate. Mechanical methods of sample preparation either require equipment not generally available in the pulp mill, or have proved too time-consuming to be useful for control work.

Sodium chlorite in acetic acid solution was tried as a reagent, because the extensive use of this material in the preparation of chlorite holocellulose has demonstrated its capacity for delignifying even large particles of wood rather uniformly. A closed flask with an attached U-tube charged with potassium iodide solution was used to retain all the oxidizing substances in the system. However, reproducible results for the total oxidizing power of the acidified chlorite could not be obtained after a specified period at a carefully controlled temperature (e.g., 30 min. at 80°C.) and the method was abandoned.

In order to apply the chlorine or permanganate number methods to highly lignified pulps, it is necessary to use a chemical method of disintegration. Hydrolysis of the polysaccharides by strong acids permits access of the oxidizing reagents to the lignin. One method of acid pretreatment is that devised many years ago by Tingle (*4*) as one step in the determination of the "bromine figure." This method employs a 9:1 mixture of hydrochloric and sulphuric acids to swell and partially dissolve the cellulose, thus exposing the lignin to the oxidizing agent.

The use of this acid mixture limits the choice of oxidant subsequently applied, because it is undesirable to use permanganate in hydrochloric acid solutions. However, the hydrolysis of pulp by 72% sulphuric acid is too slow for the present purpose, so that the use of mixed acid seems to require the use of a halogen as the oxidizing agent. Although Tingle preferred bromine, the application of chlorine derived from a standard hypochlorite solution is believed more suitable for the present purpose and it has been found very satisfactory.

The method given below represents the bleachability procedure developed jointly by The Institute of Paper Chemistry and the American Box Board Co.

METHOD OF TEST

Apparatus

1. Reaction flasks. Wide-mouth Erlenmeyer flask of 500-ml. capacity, equipped with no. 10 rubber stoppers.

2. Glass beads, to accelerate the pulp disintegration.

3. One pipet or automatic pipet, 25-ml. capacity, for delivering the hypochlorite reagent.

4. One buret, preferably of 50-ml. capacity and graduated to 0.1 ml.

5. Graduated cylinder, 50-ml. capacity.

6. Timing clock.

7. Resistance-type moisture meter (such as the Hart) or a weighing oven, for rapid determination of the moisture-free weight of the sample.

Reagents

1. Acid mixture. To 450 ml. of concentrated hydrochloric acid, carefully add 50 ml. of concentrated sulphuric acid.

2. Hypochlorite reagent. Either sodium or calcium hypochlorite may be used. The former is most conveniently prepared by diluting commercial bleaching solution (Clorox, Roman Cleanser, etc.), the latter by dissolving bleaching powder and decanting off the clear liquor for use. The concentration of the reagent should be such that not over 50% of the available chlorine is consumed during the test. For pulps containing 12 to 16% lignin, the available chlorine content of the reagent should be 12.5 to 13.5 grams per liter.

3. 0.2 *N* sodium thiosulphate. Of exact or known strength, accurate to ± 0.0005 *N* $Na_2S_2O_3$.

4. Potassium iodide, either solid or granular.

5. Starch indicator solution. Prepared according to TAPPI Standard T 609 m-42 (*1*).

Procedure

The test specimen shall consist of 1 ± 0.02 gram of moisture-free pulp, accurately determined to the nearest 0.005 gram. The following examples illustrate suitable methods of obtaining test specimens.

1. If the sample is received as a handsheet, or a finished sheet from the paper machine, determine the moisture content of the sheet with the moisture meter or by oven drying and weigh out a quantity of the sample equal to 1.00 gram of moisture-free pulp.

2. If the sample is received as slush or from wet pulps, dilute a portion and form a handsheet having the caliper for which the moisture meter is calibrated. Repulp this wet sheet to ensure thorough removal of the pulping liquor. Reform, press, and dry this sheet. Then proceed as directed in the preceding paragraph.

3. As an alternative to the above method, the sample of slush pulp can be diluted and a pulp pad formed on a Buchner funnel, using a filter paper. Wash the pad thoroughly to ensure removal of the pulping liquor. Dry the pad and place it in the weighing oven. Weigh out 1.00 gram of moisture-free pulp.

Place the test specimen in the reaction flask and add several glass beads and 30 ml. of the acid mixture. This is allowed to stand 10 min., with frequent swirling or shaking of the flask to insure complete sample disintegration.

At the end of this period, dilute the contents of the flask to 200 ml. with distilled water, add 50 grams of cracked ice, and swirl the flask for a few seconds to ensure that the temperature is brought to 0°C. or lower. By means of the pipet add 25 ml. of the hypochlorite reagent, starting the timer when half the hypochlorite has been added. Stopper the flask after addition of the hypochlorite and allow the flask to stand for 10 min. Swirl the flask contents occasionally during the reaction period. At the end of the 10-min. period, stop the oxidation by adding 5 to 7 grams of potassium iodide. Immediately restopper the flask and allow it to stand 5 min.

Remove the stopper and rinse any adhering liquid into the flask. Titrate the free iodine with sodium thiosulphate, using starch indicator near the end point.

Run a blank on the reagents.

$$\% \text{ chlorine consumed} = \frac{(B - T)(N)(3.55)}{W}$$

where

B = ml. of $Na_2S_2O_3$ required for the blank
T = ml. of $Na_2S_2O_3$ required for the sample
N = normality of $Na_2S_2O_3$
W = moisture-free weight of the sample in grams

Precision

Completed duplicate tests should agree within 0.2% chlorine consumed.

Notes

1. The glass beads merely aid in defibering the sample and are often unnecessary for laboratory handsheets.

2. Tap water may be used in place of distilled water if the amount of impurities present does not fluctuate too greatly.

3. A distinct change from pale blue or lavender to faint gray marks the end point of the titration. The end point is somewhat obscured by precipitated cellulose but is readily apparent.

4. The reagent is quite stable; therefore, the reagent blank need not be determined for every set of analyses.

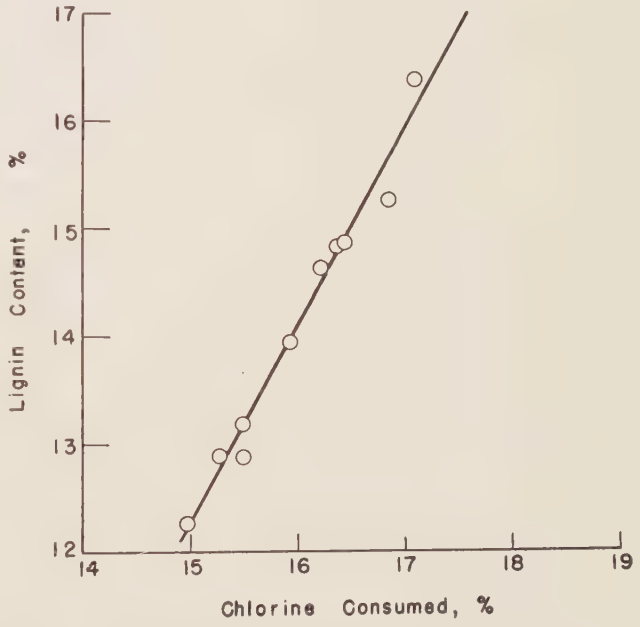

Fig. 1. Relationship between lignin content and chlorine consumption for N.S.S.C. pulps

$$y = 1.86x - 15.65$$

where

y = lignin content
x = chlorine consumed

CORRELATION BETWEEN CHLORINE CONSUMPTION AND LIGNIN CONTENT

Figure 1 depicts the relationship between chlorine consumed and lignin content for ten N.S.S.C. pulps prepared from unbarked aspen wood. Lignin contents were determined according to TAPPI Method T 222 m-50. Chlorine consumptions were determined according to the method just described, but using 30-min. acid treatment and hypochlorite oxidation times and a temperature of 20°C. Averages of duplicate determinations are plotted in Fig. 1. Good correlation was obtained, indicating that the method could be satisfactorily used as a bleachability test or cooking index for semichemical pulps.

EFFECT OF VARIABLES

The effect of hypochlorite strength upon the amount of chlorine consumed was determined on a N.S.S.C. aspen pulp which contained 12.52% lignin. Duplicate determinations were made, using 30-min. acid treatment and hypochlorite oxidation times and a temperature of 20°C. Averages of these duplicate determinations are plotted in Fig. 2. These data show that the initial concentration of the hypochlorite should be such that not over 50% of the available chlorine will be consumed during the test.

In the earlier stages the test method employed acid dissolution and hypochlorite treatment times of 30 min. each. It soon became apparent that these times would make the method too time consuming for a control procedure. The feasibility of reducing either or both of these times was therefore investigated, using a N.S.S.C. aspen pulp having a lignin content of 12.87%. Acid dissolution times of 10, 20, and 30 min. were employed. Hypochlorite oxidation times of 10, 20, 30, 40, and 50 min. were used at a temperature of 20°C. The data obtained are shown in Fig. 3.

It is apparent that the time of acid treatment is not critical, at least down to a time of 10 min., provided the sample is defibered within this time. The hypochlorite treatment time, on the other hand, is quite critical and must be closely controlled. The rapid

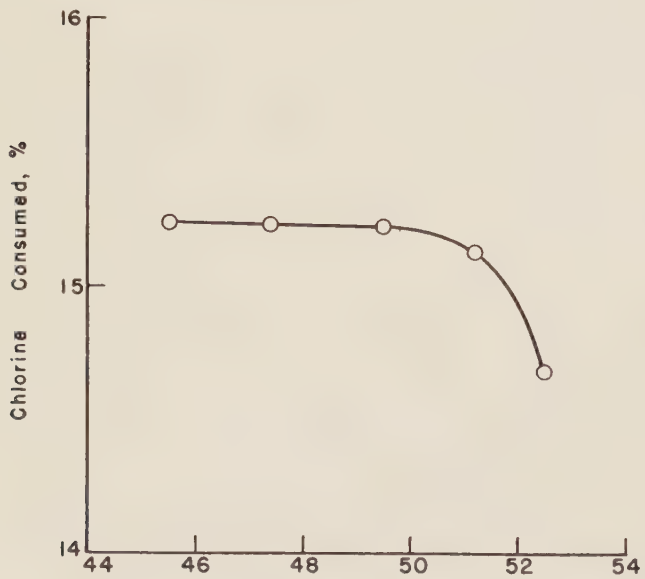

Fig. 2. Effect of chlorine available on chlorine consumed

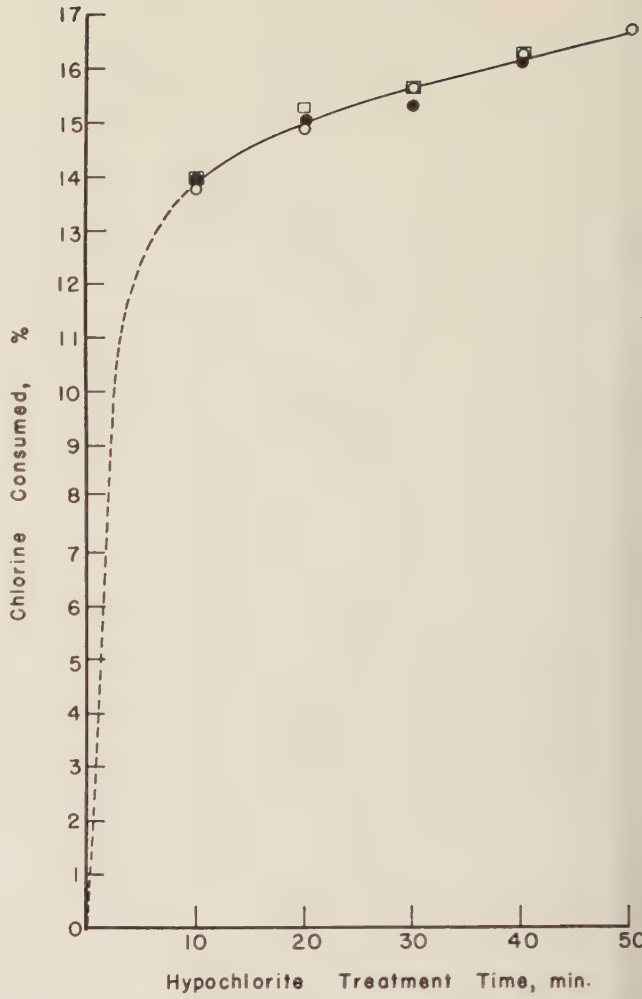

Fig. 3. Effect of acid dissolution time and hypochlorite treatment time on chlorine consumed

○ 30 min. acid time
● 20 min. acid time
□ 10 min. acid time

initial reaction of the hypochlorite is essentially complete within 10 min.

On the basis of these results, the times of both the acid dissolution and hypochlorite oxidation steps were set at 10 min.

At temperatures of 20 to 23°C., it was found that part of the chlorine was being consumed by carbohydrates in the pulp. This amounted to 0.6% chlorine consumed at 23°C. in 30 min. when purified cotton linters were used. No chlorine was consumed by the cotton linters when the test was run at 0°C.

For this reason it is preferable to carry out the test at 0°C., although any constant temperature (such as 25°C. as used in the permanganate test) will suffice.

Reasonably close control of the variables discussed here yields a simple, yet reliable method for estimating the lignin contents of semichemical pulps.

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Sulphate Black Liquor Evaporator Tube Plugging—Progress Report

W. J. HALL

he progress, to date, is reported on the probable source nd mechanism of the tube plugging in a long tube vertical ultiple effect evaporator. Observation of a dissected, ugged tube pulled from no. 1B effect of this evaporator nd analyses of individual portions of the plug are the bases r concluding that the plug is probably composed of black quor solids rather than sulphate soap. The solids from ade washings are also ruled out as comprising the plug. olished cross sections of the tube plug show evidence of ale breaking loose from the tube wall and setting up tricate channels in the liquor space. The plug probably rms after this initial scaling. It is believed that control the scale should prevent the remainder of the plug from rming. The presence of superheat in the steam to the aporators is noted. This would tend to aggravate the be scaling, which is believed to be the initial phase of ug formation. Recommendations are made to desuper-eat the steam used for evaporation and to initiate more fective boiling out procedures to keep the scale from ccumulating.

When a mill is faced with an operating problem ot usually encountered in other pulp mills of similar esign and type, the first question that may come to ind is, "What are we doing that they aren't?" Shortly fter the Springfield kraft mill of the Weyerhaeuser imber Co. started up late in 1949, trouble was ex-erienced with the evaporator tubes plugging up solid ith a black heterogeneous mass resembling black quor. At first it was thought that solids washed from ae cascade evaporator caused the tube plugging. eriodically, when the cascade evaporator needs to be ashed out due to a build-up of black liquor solids in ie cascade flue gas discharge breeching, the furnace is ut down and the liquor in the cascade dumped to the oncentrated black liquor storage tank. A flushing ith water precedes and follows the actual mucking out solids from the cascade body. These washings were mped to the weak black liquor storage tanks, rather an to the sewer to prevent river pollution. Thus, on e start-up, the cascade washings, high in inorganic ntent by analysis, are returned through the evapo-tors. Here, it was felt, was the answer to the tube gging problem.

A system for dumping cascade washings to a dump nk and pumping back to the cascades after the start-) was installed to prevent these solids from passing rough the evaporators. Using this system, the cas-des were washed out to the dump tank just prior to e shutdown on July 4, 1951. During this shutdown e weak black liquor tanks were inspected and found to free of any build up of solids or soap. Operation be-een July 4 and Labor Day was normal and the cas-cades did not have to be cleaned out. Yet, inspection of no. 1A effect which had been drilled on the July 4 shutdown showed at least 50 tubes plugged on Labor Day. Number 1B effect was not inspected at that time.

Number 1A effect was drilled out again on October 22, and no. 1B effect on Nov. 5, 1951. By Christmas, just two months later, 127 tubes were plugged in 1A effect and 28 tubes were plugged in 1B effect. The C-E cascade evaporator washings had to be dumped to the weak black liquor tanks once during this period, on about December 1, because of a plugged dump line to the new washings tank.

Although it is possible that this one dumping of cascade washings on December 1, could have caused 155 tubes to plug in 25 days, it was felt to be very unlikely, especially in view of the excessive plugging during July and August when no solids from the cascades were in the evaporator system.

While 1B effect was down for drilling on November 3, one entire plugged tube was removed from the evaporator and cut open. The holes left in the tube sheet were plugged to allow putting the effect back on the line. The location of the plug with respect to the evaporator body is shown in Fig. 1. In this case (1B effect), the plug is located in only the upper half of the tube; however, in 1A effect, many of the tubes are either plugged or thickly scaled for almost the full length of the tube. Drilling experience has shown that the tubes in 1A effect usually plug faster, harder, and deeper than the tubes in 1B effect. No plugging has been experienced in nos. 2 to 5 effects.

Figure 2 shows the general formation of the plug and Figs. 3, 4, and 5 show in detail the cross section at the top, middle, and bottom, respectively. Before photographing, the samples shown in Figs. 3, 4, and 5 were filed smooth and cleaned with an air jet to bring out the details.

By careful study of the polished specimens and knowledge of the composition of the discrete portions of the plug, it was felt that some light could be thrown on the mechanism of formation of both the "scale" and "fill" portions of the plug, as well as the probable source of these components. The "scale" portion of the plug is defined as the hard layer of coating formed on the tube wall around the plug as well as the lamellar formations embedded in the plug proper. The "fill" is defined as the granular, porous mass of solids comprising the main volume of the plug. All portions of the plug were relatively hard, brittle, and difficult to chip, even with a knife.

Carefully separated samples of the plug were taken as indicated in Fig. 2 and analyzed for inorganics, sodium,

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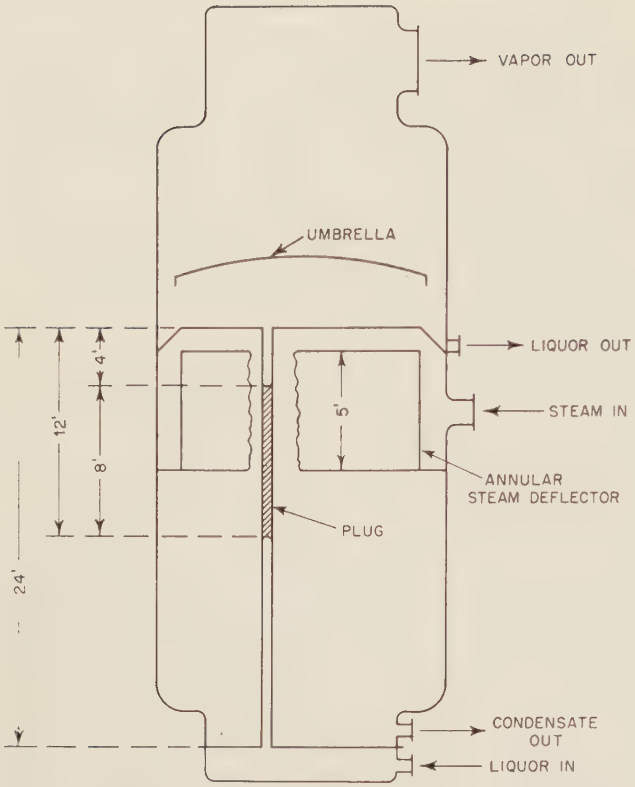


Fig. 1. Location of tube plug with respect to the evaporator body

sulphate, calcium, silica, R_2O_3 (iron and aluminum), and fatty and resin acids (acidified ether extract). The standard TAPPI method T 625 m-48 for black liquor was used to determine the inorganics (sulphated ash as NaOH), sodium sulphate (as NaOH), and sodium (as NaOH) by the uranyl zinc acetate method. Silica, R_2O_3, and calcium were run on the sulphated ash using the standard gravimetric analysis for limestone. The fatty and resin acids were weighed directly after slowly evaporating the acidified ether extract for 24 hr.

Samples of weak black liquor, sulphate soap, and solids from the cascade evaporator were also analyzed to determine if the plug could have come from any one of these. The plug could not logically come from any other source.

In Table I are compiled the results of all the samples analyzed. The conclusions that may be drawn from these data are:

1. All the plug samples showed the absence of troublesome amounts of calcium, R_2O_3, and silica, but all had relatively high inorganic, sodium, and sulphate contents as compared to black liquor, soap, and cascade solids.

2. All of the plug *scale* samples showed similar compositions. All were high in sodium, sulphate, and inorganics. Since the inner lamellas shown in Figs. 4 and 5 are identical in composition and shape to the wall scale, it is evident that they were originally formed on the tube wall and had probably broken loose during some change in the operation of the evaporator such as starting up, shutting down, or boiling out.

3. The *fill* samples of the plug were all similar with respect to their sulphate contents, but the fill samples from the top of the plug (nos. 4 and 6) had lower inorganic and sodium contents than fill sample no. 2 from the middle portion of the plug. In fact, fill sample no. 2, except for its sulphate content, most nearly resembled scale samples nos. 1 and 3 from between which it was taken. Also of interest is the fact that plug samples 1, 2, and 3 should be so similar in chemical composition and yet the scale samples (1 and 3) were definitely laid down in layers whereas the fill sample (no. 2) is granular in structure as can be seen in Fig. 4.

4. The analysis of the soap sample shows it to be very high in organics, mainly fatty and resin acids. None of the plug samples show these characteristics; therefore sulphate soap can probably be ruled out as the constituent from which the plug originates.

Table II. Boiling-Out Schedule on No. 1 Set of Evaporators Oct. 22 to Dec. 24, 1951

Date	*Duration of boil-out, hr.:min.*	*Time since previous boil-out, days*	*Number of tubes plugged during period*	
			1A effect	*1B effect*
Nov. 3	1:45	12	127	28
Nov. 5	1:45	2		
Nov. 12	1:15	7		
Nov. 19	0:20	77		
Nov. 29	1:05	10		
Dec. 10	1:15	12		
Dec. 24	1:05	14		
Av.	1:13	9		

Note: C-E cascade evaporator washed out to the weak liquor tanks on about Dec. 1, 1951. No. 1A effect drilled out and on the line on Oct. 22, 1951. No. 1B effect drilled out and on the line on Nov. 5, 1951.

Table I. Chemical Composition[a] of the Evaporator Tube Plug, Black Liquor Solids, Sulphate Soap, and Cascade Solids
Sample Description and Sample No. as Noted in Fig. 2—Tube Plug

	Outer scale, middle of plug—no. 1	*Inner scale, middle of plug—no. 3*	*Outer scale, upper portion of plug—no. 5*	*Fill, lower portion of plug—no. 2*	*Fill, top of plug-contained flakes—no. 4*	*Fill, upper portion of plug-few flakes—no. 6*	*Black liquor solids*	*Sulphate soap solids*	*Solids from cascade washings*
Inorganics, % (sulphated ash) (as NaOH)	68.7	65.4	77.0	66.2	49.0	42.2	34.6	13.3	31.3[b]
Organics, % (100% inorganics)	31.3	34.6	23.0	33.8	51.0	57.8	65.4	86.7	66.7
Na as NaOH, % (U-Z-A method)	69.4	67.3	79.3	63.0	49.5	39.6	33.0	12.3	34.7
SO_4 as NaOH, %	7.9	7.0	8.6	3.1	3.8	3.2	0.6	0.0	3.2
CaO, %	0.23	0.38	Trace	0.10	Trace	0.0	0.0	0.9	0.0
R_2O_3, %	0.0	0.0	Trace	0.0	0.0	0.0	0.0	0.0	0.01
SiO_2, %	0.0	0.0	0.0	0.0	0.0	0.0	Trace	0.0	0.3
Acidified ether extract (fatty and resin acids), %		1.0		...	5.7	3.5	9.7	82.3	...

[a] Dry basis.
[b] Sample not sulphated before ignition. The ignition product was calculated to sulphated ash for comparison purposes by subtracting the SO_4 content (3.2%) converted to Na_2SO_4 from the total ash to get the % Na_2CO_3 in the ash (ash is assumed to be only Na_2CO_3 and Na_2SO_4) and adding the per cent Na_2SO_4 (as NaOH) to the Na_2CO_3 content expressed as NaOH to obtain the inorganics as NaOH.

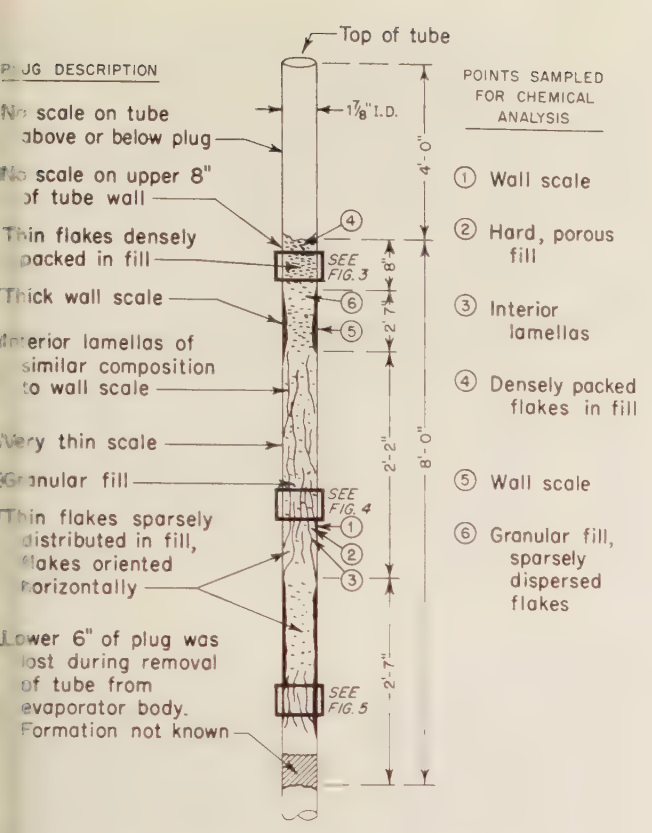

Top of tube
PLUG DESCRIPTION
No scale on tube above or below plug
No scale on upper 8" of tube wall
Thin flakes densely packed in fill
Thick wall scale
Interior lamellas of similar composition to wall scale
Very thin scale
Granular fill
Thin flakes sparsely distributed in fill, flakes oriented horizontally
Lower 6" of plug was lost during removal of tube from evaporator body. Formation not known
1⅞" I.D.
SEE FIG. 3
SEE FIG. 4
SEE FIG. 5
4'-0"
8"
2'-7"
2'-2"
8'-0"
2'-7"
POINTS SAMPLED FOR CHEMICAL ANALYSIS
① Wall scale
② Hard, porous fill
③ Interior lamellas
④ Densely packed flakes in fill
⑤ Wall scale
⑥ Granular fill, sparsely dispersed flakes

Fig. 2. Cross section of evaporator tube plug from 1B effect

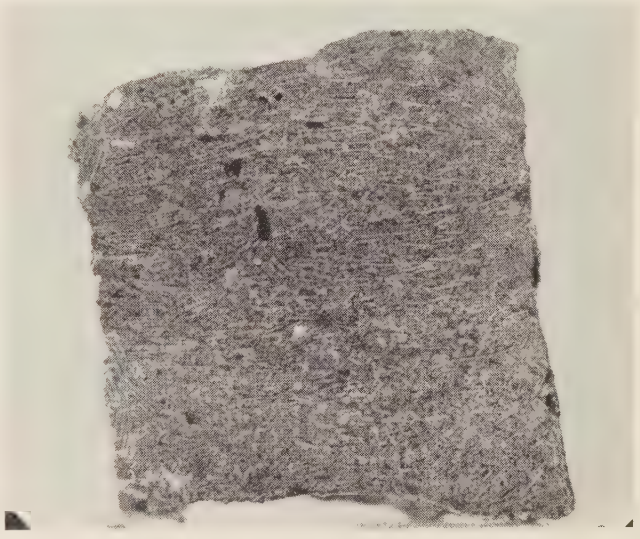
5. The composition of the solids from the cascade evaporator is almost identical with that of black liquor. However, since 50 tubes in 1A effect plugged between July 4 and Sept. 1, 1951 when no solids from the cascades were in the weak liquor system, it is felt that the solids washed from the cascade evaporator to the weak liquor tanks do not comprise the plug in question.

6. By a process of elimination, then, the solids comprising the plug must originate in the black liquor. However, the composition of the black liquor sample does not compare directly with any of the plug samples. Nor can it be expected to in the case of the scale samples since the scale formed on the tube walls must be built up by the preferential precipitation from the black liquor of inorganic compounds which have reached saturation in the liquor (*1, 4*). The formation of this water-soluble scale is well known in black liquor evaporation and is usually composed of inorganic compounds exhibiting an inverted solubility curve.

The fill samples all have higher inorganic contents than does the black liquor sample. It is because of this difference in inorganic contents that the fill cannot definitely be attributed to black liquor solids, unless wild assumptions are made as to changes probably taking place in the tube during plug formation. However, the appearance of the fill and scale portions of the plug are of value in that a probable mechanism of plugging can now be framed, based on the evidence presented by the photographed specimens.

From the general appearance of the plug with its layers of scale embedded in the fill, the plug could have started with wall scale breaking loose and falling out into the liquor space, thus setting up a system of intricate channels through which the liquor would have to rise. The mechanism of fill formation remains unknown, but might be determined with continued work; however, for present considerations, all that need be known is that the fill is probably formed after the scale network has been set up in the tube. The Na_2SO_4 content of the black liquor solids from Table I is 0.6% as NaOH or 1.1% as Na_2SO_4, which is well below the critical limit of 6% stated by Seavoy (*4*), above which the tendency toward sodium sulphate scaling is enhanced. This might lead to the thought that some factor other than the liquor was the causative force.

An investigation into the possible causes of scale formation led to the discovery that the 35 p.s.i. steam to the evaporators contained about 85°F. superheat. Under certain conditions, excessive superheat in steam is known to cause tube scaling (*2, 4*). This superheat in the steam, coupled with the possibility that our boiling out procedure may be inadequate (*3*) could well be causing the tubes to scale excessively. The no. 1 set of evaporators, during the period Oct. 22–Dec. 24, 1951, was boiled out seven times for an average of about 1¼



Cross Section

End View

Fig. 3. Tube plug; specimen from top of plug as shown in Fig. 2

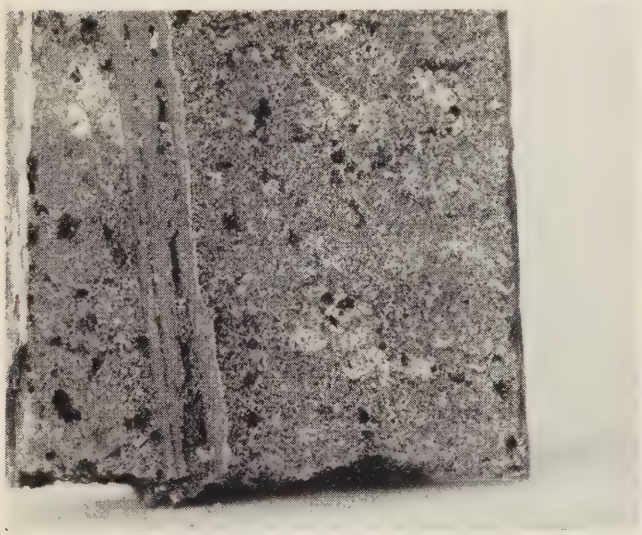
Composition: Inorganics, 49.0; Na as NaOH, 49.5; Na_2SO_4 as NaOH, 3.8; CaO, trace; R_2O_3, 0.0; SiO_2, 0.0.

hr. per boil out with the average time between boil outs being about 9 days (Table II). It was during this time that 155 tubes plugged in nos. 1A and 1B effects.

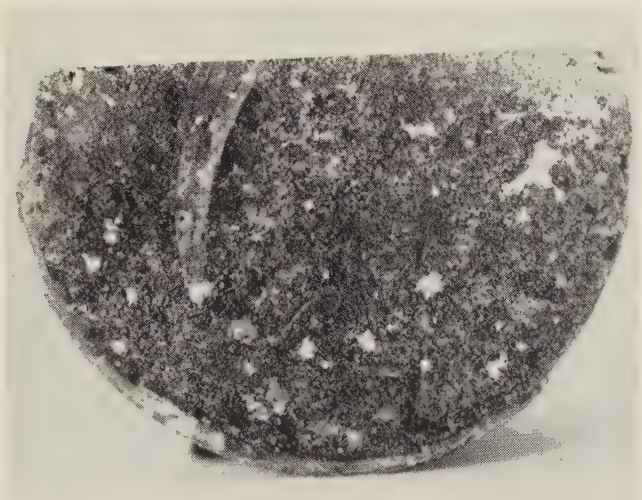
The next logical step, then, was to supply saturated steam to the evaporators and either lengthen the boiling out periods or boil out more frequently or both, to keep the scale from accumulating and restricting the liquor flow in the tubes.

A contact-type desuperheater, utilizing condensate from the C-E air heater, was installed in the steam line to the evaporators on Jan. 23, 1952. Limited weak black liquor storage capacity was restricting the duration and frequency of boil-out periods in the evaporators. To obviate this problem, piping changes were made on Jan. 21, 1952, to allow liquor circulation through nos. 5, 4, 3, and 2 effects and back to storage while boiling out nos. 1A and 1B effects with water.

At the time of this writing, six weeks after the installation of the desuperheater and initiation of the modified boiling-out procedures, inspection of nos. 1A and 1B effects revealed that two tubes had plugged in no. 1B effect and two tubes had plugged in no. 1A effect. This is a decided improvement over previous operation.



Cross Section



End View

Fig. 4. Tube plug; specimen from middle of plug as shown in Fig. 2

Composition:

	Fill	*Outer Scale*	*Inner Scale*
Inorganics	66.2	68.7	65.4
Na as NaOH	63.0	69.4	67.3
Na_2SO_4 as NaOH	3.1	7.9	7.0

Cross Section

End View

Fig. 5. Tube plug; specimen from bottom of plug as shown in Fig. 2

CONCLUSIONS

Scale formation is probably the initial phase of tube plugging; therefore, control of the scaling tendency should help to prevent plug formation.

The scale may best be controlled by removing the superheat in the steam and employing more effective boiling out procedures.

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Credit is due to G. C. Archer, Recovery Department Foreman, for his assistance in determining the probable causes of the tube scaling and F. Thompson for devising the modified boiling out procedure in nos. 1A and 1B effects.

The Lethality of Methyl Mercaptan to King Salmon as Influenced by Variation of the Volume of Test Solution

E. P. HAYDU, H. R. AMBERG, and R. E. DIMICK

Bioassays, using king salmon, conducted in solutions of methyl mercaptan of varying concentrations and volumes showed that increases in volume of test solution resulted in subsequent decrease in the concentration of mercaptan necessary to effect 100% mortality.

PRELIMINARY selective bioassays (*1*) conducted to determine the effects of kraft mill waste components on Salmonoid fishes of the Pacific Northwest showed methyl mercaptan to be lethal at a concentration of approximately 1.0 p.p.m. During the course of these studies, it was found that differences in the volume of test solutions produced varied effects on the test fish. This condition was pronounced with the volatile constituents, namely, methyl mercaptan and hydrogen sulphide. Several bioassays, using king salmon (*Oncorhynchus tshawytscha*) were conducted in solutions of methyl mercaptan at different concentrations and varying volumes to determine the relationship between volume and lethality of methyl mercaptan. As yet no attempts have been made to determine the effects of varying volumes on test fish using nonvolatile compounds.

PROCEDURE

Young king salmon seined from nearby streams ranging from 6 to 7 cm. in length and weighing 7 to 8 grams each were used in these tests. The tests were carried out in 18-liter cylindrical jars having a surface area of 86.6 sq. in. and varying depths. The bioassays were conducted at mercaptan concentrations ranging from 0.55 to 0.95 p.p.m. for a test period of 120 hr. at a temperature of 17.5°C. All bioassays were conducted in solutions having 5 p.p.m., or more, dissolved oxygen and experiments which at termination indicated D.O. contents below 5 p.p.m. were disregarded. A minimum of ten fish at each concentration was considered adequate to give fairly conclusive evidence in establishing lethal concentrations.

The second phase of this investigation was conducted in 18-liter cylindrical jars (86.6 sq. in. of surface area) at varying depths and with an initial mercaptan concentration of 5 p.p.m. These tests were conducted without test fish to ascertain the loss of methyl mercaptan under quiescent conditions. Methyl mercaptan determinations were made at 24 and 48-hr. intervals to determine the rate of loss of this compound.

RESULTS

Table I shows that the lethality of methyl mercaptan decreases with subsequent decreases in the depth of test solution at both of the concentrations employed. An increase in depth of mercaptan solution from 58 to 208 cm. resulted in an increase in mortality of 100% at an initial concentration of 0.55 p.p.m.

Table I. The Effect of Varying Volumes of Methyl Mercaptan Solutions at 0.95 and 0.55 P.P.M. Concentration on King Salmon

Volume liters	*Depth, cm.*	*Per cent survival* — *0.95 p.p.m. mercaptan added*	*0.55 p.p.m. mercaptan added*
18	208	...	0
16	185	...	20
10	115	0	50
9	104	10	...
8	92	10	90
7	81	...	90
6	69	50	...
5	58	...	100
4	46	90	...
2	23	100	...

Table II shows that the concentration of methyl mercaptan required to effect 100% mortality varies from 0.55 to 0.95 p.p.m. depending upon the volume or depth used in the test.

The loss of mercaptan through diffusion or possibly oxidation was found to be considerable in 24 and 48 hr. of quiescent storage at all depths, the greatest loss occurring at the shallow depth (Table III). There was little difference in the rate of loss from the 12 and 16-liter volumes.

DISCUSSION

Considerable work has been reported in the literature on selective bioassays but only recently attention has been directed toward volume or surface to depth relationship existing in the test aquaria. Doudoroff, *et al.* (*2*) recommend that the depth of the liquid should be uniform in all parallel tests and should never be less than 6 in. No relationship, however, was established between depth and lethality of volatile constituents. The surface to depth relationship becomes of extreme importance when conducting bioassays on volatile constituents such as methyl mercaptan and sulphides. The re-

Table II. Concentration of Methyl Mercaptan Required to Effect 100% Mortality of King Salmon at Various Volumes

Surface Area = 86.6 Sq. In.

Volume liters	*Depth of aquarium, cm.*	*Methyl mercaptan concentration for 100% mortality*
18	208	0.55
16	185	0.65
12	139	0.75
10	115	0.85
10	115	0.95

P. HAYDU, Research Biologist, Fish and Game Management, Oregon State College; H. R. AMBERG, West Coast Resident Engineer, National Council for Stream Improvement; and R. E. DIMICK, Head of the Department of Fish and Game Management, Oregon State College, Salem, Ore.

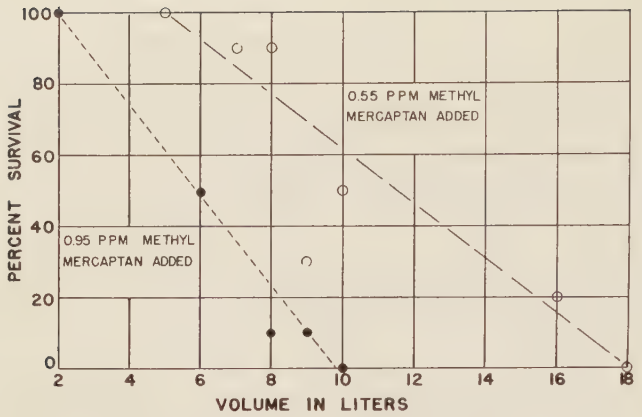

Fig. 1. The effect of volume upon the toxicity of methyl mercaptan to king salmon

sults of the experiments reported show conclusively that the lethality of mercaptan solutions varies considerably depending upon the surface to depth relationship (Fig. 1). Figure 2 shows that the concentration of methyl mercaptan required to effect 100% mortality is a linear function of the volume over the range of volumes studied in these experiments. A twofold increase in methyl mercaptan is required to effect 100% mortality when the volume is decreased from 18 to 10 liters. There are several possible explanations for this phenomenon. Since methyl mercaptan is a volatile compound, the rate of escape or diffusion should be influenced by the depth or the distance through which the compound must diffuse. It is also possible that a portion of the mercaptan is oxidized to compounds which are less lethal. Another plausible explanation for the volume effect seems to be the fact that the test organism requires a given quantity of toxic constituent before it is adversely affected. Calculation of the weight of methyl mercaptan for each volume shows that approximately 10 mg. of methyl mercaptan were required to effect 100% kills. The volume effect may also be caused by a combination of all three of the above factors.

Figure 3 shows the change in mercaptan concentration occurring in various volumes over a period of 48 hr. It is evident that a considerable loss of mercaptan occurs over the 48-hr. period, the loss decreasing as the concentration of mercaptan decreases.

The per cent loss of mercaptan from various volumes is plotted in Fig. 4. As the volume or depth of con-

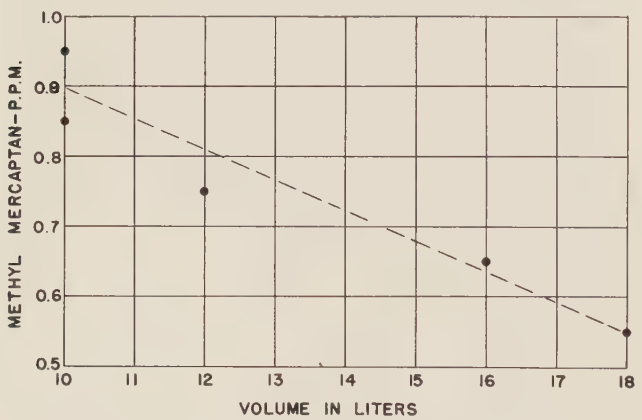

Fig. 2. The concentration of methyl mercaptan required to effect 100% mortality of king salmon at various volumes

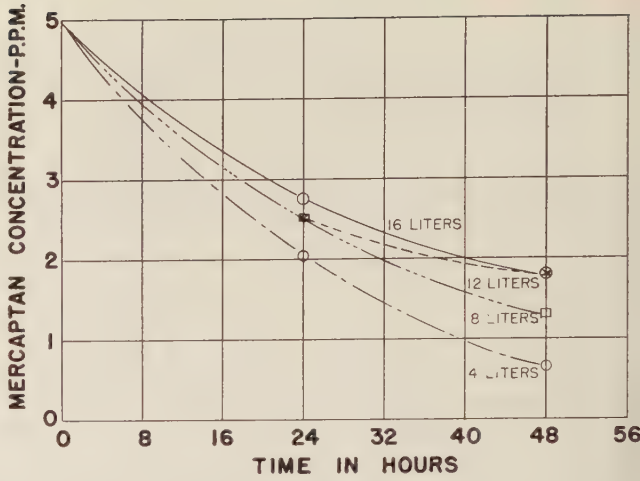

Fig. 3. The loss of methyl mercaptan from various volumes of mercaptan solutions with time

tainer is increased the loss of mercaptan decreases and at a volume of 12 liters or more no difference in loss was detected. In 4 liters of test solution 86.5% of the mercaptan was dissipated at the end of 48 hr. when starting with an initial concentration of 5 p.p.m. It must be remembered that the lower the initial concentration of mercaptan used the slower will be the loss since the concentration gradient or driving force is appreciably decreased. However, when the lethal concentration is approached a slight loss of mercaptan will greatly affect its toxicity to the test organisms. Since these tests were conducted under quiescent conditions it is to be expected that the loss of mercaptan would be much more rapid under natural conditions. Turbulence in streams actually decreases the effective depth through which diffusion operates. In practice it will be found that although agitation and turbulence cannot readily be expressed in standardized units or terms, they exert a dominant influence upon the observed rate of loss of volatile constituents to the atmosphere. The results of these experiments cannot be correlated with natural conditions but it may be safely stated that the loss of mercaptan would be much more rapid in a turbulent stream than in a sluggish stream.

SUMMARY AND CONCLUSIONS

Preliminary bioassays showed that differences in the volume of methyl mercaptan produced varied effects on

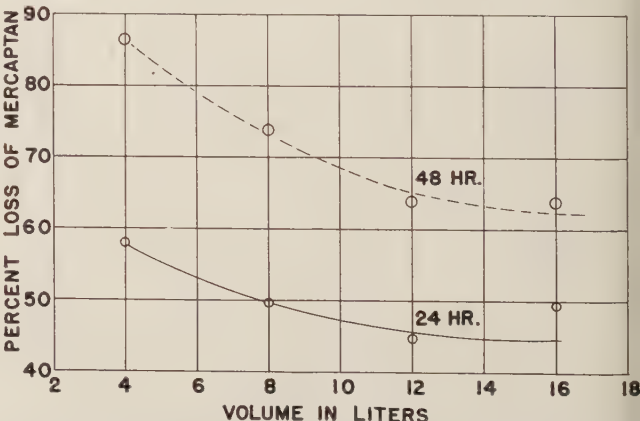

Fig. 4. Per cent loss of methyl mercaptan from various volumes of mercaptan solution

Table III. The Loss of Methyl Mercaptan as Affected by Variation of Volume of Test Solution

Volume, liters	Depth, cm.	Initial mercaptan concentration, p.p.m.	Final concentration, p.p.m. After 24 hr.	Final concentration, p.p.m. After 48 hr.
16	185	5.0	2.52	1.80
12	139	5.0	2.76	1.80
8	92	5.0	2.52	1.32
4	46	5.0	2.04	0.67

the test fish. Bioassays, using king salmon, conducted in solutions of methyl mercaptan of varying concentrations and volumes showed that increases in volume of test solution resulted in subsequent decreases in the concentration of mercaptan necessary to effect 100% mortality of the test organisms. In 18 liters of test solution 0.55 p.p.m. of methyl mercaptan was required to effect 100% mortality and in 10 liters of solution approximately 0.90 p.p.m. of mercaptan was required to effect the same degree of lethality. Generally speaking, the concentration of methyl mercaptan required to effect 100% mortality of king salmon was a linear function of the depth when the depth was varied from 23 to 208 cm. and surface area was maintained constant. The loss of mercaptan from solution by diffusion or possibly oxidation was found to be considerable over a 48-hr. period. In 4 liters of solution 86% of the chemical was dissipated at the end of 48 hr. and in 16 liters of solution the loss was 62% at the end of 48 hr. The rate of diffusion of this volatile component from the test solution is probably the primary cause for the differences in the lethal concentration at various volumes.

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A Method for the Estimation of Decay in Douglas-Fir Wood Chips

WESLEY L. PEARL

A method has been presented for the estimation of the amount and type of decay in Douglas-fir wood chips. The relative amounts of the predominant type of decay can be determined generally within limits of 5 to 10%. Including the time necessary to dry the sample, 36 to 48 hr. are required to carry out the test. The method is recommended as a control test for the quality of wood chips from a given source or group of sources.

Increasing demands for all products of the forest together with decreasing supplies of accessible timber have resulted in the necessity for more thorough usage of the available timber. In the past many sawmills have shipped sawmill slabs and waste wood to pulp mills where they were converted to chips. Sawmills, veneer and plywood plants now are going a step farther by installing chippers at their own plants and selling the chips to the pulp mills. As more and more former wood wastes are utilized, the ability of the pulp mills to purchase their wood supply intelligently becomes more difficult. Usually, the only check on the quality of the wood is a visual examination by a scaler for logs or by a screen operator for purchased chips. The logs can be graded by a set of arbitrary standards with proper discounts being made for factors that lower quantity or quality as knotty wood, crooked wood, decayed wood, undersized sticks, etc. Chip grading is much more difficult than log grading. Bark, char, and decay are usually determined in wood chips by a visual examination. Bark and char can be easily separated in a sample. Decay is hard to evaluate by a visual examination; the color of the wood may be caused by moisture or decay, incipient decay is not always perceptible, some kinds of advanced decay appear as sound wood until crumbled in the fingers, etc.

It is desirable to resolve the amount, type, and extent of decay because of the effect such decay may have on the yield and strength of pulp (*1–5*). One of the few references in the literature to such a test is the report by Morgan (*6*). He found that the 1% NaOH solubility of aspen-wood sawdust gave a good indication of the amount of rot. An attempt has been made to develop a test to determine the type and amount of decay in Douglas-fir wood chips.

Douglas-fir rots were divided into three classifications: (1) lignin-destroying rots commonly referred to as "white-pocket" rots, (2) cellulose-destroying rots normally called "brown" rots, and (3) a combination cellulose and lignin-destroying rot (or incipient stage of the former) often referred to as "dote." White-pocket rots even through advanced stages tend to stand up and be accepted under the chipping and screening operations; the brown rots tend to pulverize during chipping and to be rejected as dust in the screen room; dote-type rots are spongy and crumbly but tend to be incompletely removed in the screen room. For purposes of clarity, the term advanced decay will refer to decay that is plainly a factor in breaking down the wood cells while incipient rot will apply to the wood that is affected (usually noticed by a color change) but visually retains its structural characteristics.

PREPARATION OF WOOD SAMPLES

Several samples of sound wood and different types and degrees of decayed wood were selected from the

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Longview Fibre Co. wood room. The specimens were chipped or sawed, dried at 90°F. to a moisture content of 5 to 8% and ground in a Weber laboratory pulverizing mill until all of the material passed through a 40-mesh screen. The pulverized samples were screened through a 100-mesh screen. It was found that the percentage of groundwood retained on the 100-mesh screen differed for the various type rots. The yields of the original samples not passing through a 100-mesh screen were 50 to 60% for sound wood and white-pocket rots, 25 to 30% for dote, and 15 to 20% for brown rots. This served as a rough test for the presence of high percentages of the latter two rots.

Samples containing various percentages of sound and decayed woods were prepared by mixing weighed quantities of the two before grinding or after grinding and screening.

EXPERIMENTAL PROCEDURES AND RESULTS

Of the many analytical methods tried, the following properties were found useful in the development of a decay key for Douglas-fir.

1. The color of the filtrate from a boiling ethyl alcohol extraction of the ground sample.
2. The color of the solution after boiling the ground sample in water for a given time.
3. The color of the boiling-water extract after treatment with a small amount of caustic.

A 1.5-gram sample of the pulverized fraction passing through a 100-mesh screen was digested under reflux in 75 ml. of a denatured alcohol (once-distilled Shellacol) for 5 min. It was filtered immediately on a Buchner funnel.

The color and intensity of the color of the resulting filtrate were dependent on the amount and kind of

Table I. Blends of Decayed- and Sound-Wood Samples of Douglas-Fir

Per cent blend used in sample	*When blended*	*Alcohol extract*: *Per cent blend converted to unground sample*	*Std. No.*	*Untreated water extract*: *Per cent blend converted to unground sample*	*Std. No.*
100 S_1		100 S_1	1A	100 S_1	1B
75 S_1—25 IWP_1	Be	75 S_1—25 IWP_1	1A	75 S_1—25 IWP_1	1B
75 S_1—25 WP_1	Be	75 S_1—25 WP_1	3A	75 S_1—25 WP_1	2B–
50 S_1—50 IWP_1	Be	50 S_1—50 IWP_1	2A–	50 S_1—50 IWP_1	1B–
50 S_1—50 WP_1	Be	50 S_1—50 WP_1	4A	50 S_1—50 WP_1	2B
25 S_1—75 IWP_1	Be	25 S_1—75 IWP_1	2A	25 S_1—75 IWP_1	2B–
25 S_1—75 WP_1	Be	25 S_1—75 WP_1	4A	25 S_1—75 WP_1	3B
100 IWP_1	...	100 IWP_1	3A	100 IWP_1	2B
100 WP_1	...	100 WP_1	5A	100 WP_1	4B–
75 S_1—25 IWP_1	G	75 S_1—25 IWP_1	1A	75 S_1—25 IWP_1	1B
75 S_1—25 WP_1	G	75 S_1—25 WP_1	3A	75 S_1—25 WP_1	2B–
50 S_1—50 IWP_1	G	50 S_1—50 IWP_1	2A–	50 S_1—50 IWP_1	1B
50 S_1—50 WP_1	G	50 S_1—50 WP_1	4A–	50 S_1—50 WP_1	2B
25 S_1—75 IWP_1	G	25 S_1—75 IWP_1	2A	25 S_1—75 IWP_1	2B–
25 S_1—75 WP_1	G	25 S_1—75 WP_1	5A	25 S_1—75 WP_1	3B
50 WP_1—50 IWP_1	G	50 WP_1—50 IWP_1	5A	50 WP_1—50 IWP_1	3B
25 WP_1—75 IWP_1	G	25 WP_1—75 IWP_1	4A–	25 WP_1—75 IWP_1	3B–
100 S_2		100 S_2	1A	100 S_2	1B–
75 S_2—25 WP_2	Be	75 S_2—25 WP_2	3A–	75 S_2—25 WP_2	2B–
50 S_2—50 WP_2	Be	50 S_2—50 WP_2	4A–	50 S_2—50 WP_2	2B
25 S_2—75 WP_2	Be	25 S_2—75 WP_2	4A	25 S_2—75 WP_2	3B
75 S_2—25 WP_2	G	75 S_2—25 WP_2	3A–	75 S_2—25 WP_2	1B
50 S_2—50 WP_2	G	50 S_2—50 WP_2	4A–	50 S_2—50 WP_2	2B
25 S_2—75 WP_2	G	25 S_2—75 WP_2	4A	25 S_2—75 WP_2	3B
75 S_1—25 D_1	G	81 S_1—19 D_1	4A–	64 S_1–36 D_1	2B–
50 S_1—50 D_1	G	56 S_1—42 D_1	5A	37 S_1—63 D_1	3B
25 S_1—75 D_1	G	29 S_1—71 D_1	6A–	17 S_1—83 D_1	4B–
100 ID_1		100 ID_1	3A	100 ID_1	2B–
100 D_1		100 D_1	6A	100 D_1	4B
50 D_1—50 ID_1	Be	50 D_1—50 ID_1	5A	50 D_1—50 ID_1	3B
25 D_1—75 ID_1	G	19 D_1—81 ID_1	5A	36 D_1—64 ID_1	3B–
50 D_1—50 ID_1	G	42 D_1—58 ID_1	6A–	63 D_1–37 ID_1	3B
75 S_1—12½ D_1—12½ WP_2	G	78 S_1— 9 D_1—13 WP_2	3A	69 S_1—19 D_1—12 WP_2	2B–
50 S_1—25 D_1—25 WP_2	G	54 S_1—19 D_1—27 WP_2	5A–	43 S_1—36 D_1—21 WP_2	2B
50 S_1—37½ D_1—12½ WP_2	G	56 S_1—30 D_1—14 WP_2	5A–	40 S_1—50 D_1—10 WP_2	3B–
50 S_1—12½ D_1—37½ WP_2	G	52 S_1— 9 D_1—39 WP_2	4A	46 S_1—19 D_1—35 WP_2	3B–
25 Si—50 D_1—25 WP_2	G	29 S_1—42 D_1—29 WP_2	6A–	18½ S_1—63 D_1—18½ WP_2	3B
25 S_1—25 D_1—50 WP_2	G	27 S_1—19 D_1—54 WP_2	5A	21 S_1—36 D_1—43 WP_2	3B
100 S_3		100 S_3	1A	100 S_3	1B
95 S_3— 5 $(Br+WP)_1$	G	96 S_3— 4 $(Br+WP)_1$	3A	92 S_3— 8 $(Br+WP)_1$	2B–
90 S_3—10 $(Br+WP)_1$	G	93 S_3— 7 $(Br+WP)_1$	5A	84 S_3—16 $(Br+WP)_1$	2B
85 S_3—15 $(Br+WP)_1$	G	89 S_3—11 $(Br+WP)_1$	6A–	77 S_3—23 $(Br+WP)_1$	3B
80 S_3—20 $(Br+WP)_1$	G	85 S_3—15 $(Br+WP)_1$	6A	71 S_3—29 $(Br+WP)_1$	3B
95 S_3— 5 Br_1	G	97 S_3— 3 Br_1	5A	85 S_3—15 Br_1	2B–
90 S_3—10 Br_1	G	94 S_3— 6 Br_1	6A	73 S_3—27 Br_1	3B–
85 S_3—15 Br_1	G	91 S_3— 9 Br_1	7A	63 S_3—37 Br_1	3B
80 S_3—20 Br_1	G	87 S_3—13 Br_1	7A+	55 S_3—45 Br_1	4B–
90 S_3—10 WP_2	G	90 S_3—10 WP_2	1A	90 S_3—10 WP_2	1B
80 S_3—20 WP_2	G	80 S_3—20 WP_2	2A	80 S_3—30 WP_2	2B–
70 S_3—30 WP_2	G	70 S_3—30 WP_2	3A	70 S_3—30 WP_2	2B–
60 S_3—40 WP_2	G	60 S_3—40 WP_2	4A–	.....	....
50 S_3—50 WP_2	G	.....	....	50 S_3—50 WP_2	2B
25 S_3—75 WP_2	G	.....	....	25 S_3—75 WP_2	3B
90 S_3—10 D_1	G	93 S_3— 7 D_1	4A	84 S_3—16 D_1	1B
80 S_3—20 D_1	G	85 S_3—15 D_1	5A	71 S_3—29 D_1	2B–
70 S_3—30 D_1	G	77 S_3—23 D_1	4A	58 S_3—42	3B–
60 S_3—40 D_1	G	68 S_3—32 D_1	5A	47 S_3—53	3B
50 S_3—50 D_1	G	.....	....	37 S_3—63 D_1	3B
25 S_3—75 D_1	G	.....	...	17 S_3—83 D_1	4B–

Notes: Be—mixed before grinding. G—mixed after grinding. S—sound-wood sample. WP—white-pocket rot. D—dote rot. Br—brown rot. All rots are advanced stage unless marked (I) to designate incipient stage decay.

decay present in the original sample. The colors ranged from colorless to a faint yellow for sound wood to a strong yellow for advanced white-pocket rot, deep reddish yellow for advanced dote and a dark orange brown for advanced brown rot. Low percentages of brown rot gave about the same color and depth of color as medium percentages of dote and high percentages of white-pocket rots.

A set of six alcohol-extract standards was arbitrarily arranged in about equal divisions from near colorless (no. 1A) to a deep reddish yellow (no. 6A).

The results of using these standards with several blends of sound wood and known rots are tabulated in Table I. The relative amounts of rot present in the samples as tested are listed followed by the percentage that would have been in unground samples to give the same result. The conversion factors used were based on the average percentage of each type of rot that passed through a 100-mesh screen after grinding: 50% for sound wood and white-pocket rots, 70% for dote rots, and 85% for brown rots.

The sensitivity of this test was increased by comparing differences in the spectral-transmittance curves of the alcohol extracts. The curves were run on a Beckman model-B spectrophotometer using distilled water as the reference liquid. The sound samples were characterized by an extremely rapid increase in transmittance in the region 360 to 420 mmu and a leveling off through the remainder of the visible range. The decayed samples did not show as rapid an increase in transmittance to 420 mmu nor did they level off as completely after 420 mmu. The average slope of the transmittance curves between 360 and 420 mmu, and the per cent transmittance at 490 mmu were used as the basis for this spectrophotometric method of rot determination. Further details are not given since the results are dependent on the equipment and conditions used and therefore not as universally applicable as the method just presented.

Alcohol extractions of the three types of incipient decay tested similarly to smaller quantities of the advanced decay, e.g., 100% incipient white-pocket rot gave results comparable with 25% advanced white-pocket rot.

If the alcohol extraction described above indicated the presence of decay but did not definitely establish the type, a water extraction was carried out. A 1.5-gram sample of the groundwood that was retained by the 100-mesh screen was refluxed in 75 ml. of boiling distilled water for 5 min. The mixture was filtered immediately on a Buchner funnel. A few drops of a NaOH solution were added to one half the filtrate while not so that the pH was above 10. The NaOH treated portions were allowed to stand uncovered overnight.

The color of the untreated extract was similar to but not as deep as that obtained by the alcohol extraction. A set of four untreated water-extract standards was prepared for comparison purposes as was done with the alcohol-extract standards. The results of several types of blended sound- and decayed-wood samples are summarized in Table I. The conversion factors for obtaining the unground-sample percentages of decay were obtained from the average percentage of each type of rot that remained on a 100-mesh screen after grinding: 60% for sound-wood and white-pocket rots, 30% for

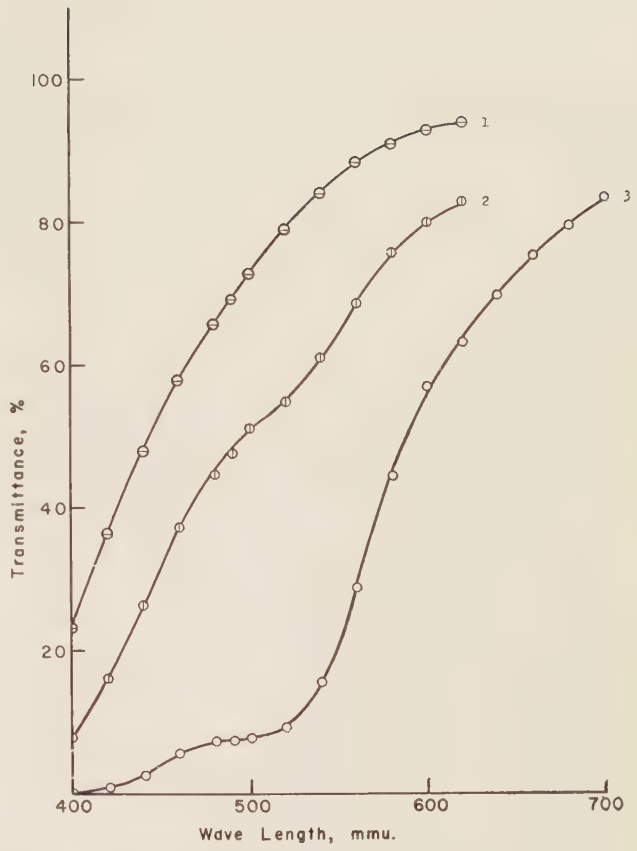

Fig. 1. Transmittance of NaOH-treated water extracted samples

(1) Advanced white-pocket rot. (2) Advanced dote rot. (3) Sound wood.

dote rots, and 15% for brown rots. Spectral transmittance curves could not be used because of the tendency for some solutions to cloud and materially lower the light transmittance of the solutions.

The relationship of incipient to advanced degrees of decay was similar to that of the alcohol extracted samples.

The NaOH-treated water extract of all sound-wood and brown-rot samples developed a deep orange-brown coloration. White-pocket and dote-type rots ranged from this deep orange brown to an intense yellow as the percentage rot increased. Standards could not be made from these alkaline water extracts since the color continued to change with time. Other stable similarly colored substances might be prepared for such a purpose. It was found more desirable, however, to use the relative amounts of light transmitted as a guide to the amount of decay present. Satisfactory results were obtained by using a light source and photocell sensitive in the visible range or by using a spectrophotometer at an optimum wave length. The latter gave more precise results. The spectral-transmittance curves of the solutions from sound wood leveled off in the range 480 to 500 mmu (see Fig. 1). Solutions from white-pocket and dote rots gave higher transmittance values throughout. Table II lists the results of several blends of sound and decayed wood based on the variation in transmittance at a wavelength of 490 mmu.

The intensity of the colors from the caustic-treated water extracts of incipient and advanced white-pocket and dote rot samples were within the same range, i.e.,

a 50% incipient white-pocket rotted sample tested similarly to a 50% advanced white-pocket rotted sample. This characteristic limited the use of this test to samples in which incipient and advanced decays could definitely be distinguished from each other by the other tests.

Pieces of bark and blue-stained chips have been found to increase or change the alcohol and untreated water-extract colors disproportionately. It is therefore necessary to remove such materials before the chips are ground.

The extraction was nearly complete after 3 min. of digestion. Beyond 3 min., 30 to 60 sec. variation in digestion time gave little difference in the depth of color.

The intensity of the color of the extract is proportional to the ratio of groundwood to solvent within the range used. The ratio should be selected to give a color sufficiently intense to allow a workable range between decayed and sound wood.

The alcohol and untreated water extracts do not require time for full color development. The caustic-treated water extract reaches maximum color after 16 to 18 hr., and noticeably starts to change color after 48 hr. As previously mentioned, the untreated water extracts will cloud up with time.

The amount of caustic added to the alkalized water extract is not critical as long as the pH of the solution is raised above 10. The depth of color increases with increase in pH up to this point.

Excellent reproducibility was obtained on duplicate tests of the same samples. The precision of the method is indicated by the ranges of decay listed in the decay key (see below), Table III. The accuracy of the results is dependent on the proper selection of samples representing 100% decay for use in the calibration of the method.

DECAY KEY

By means of a combination of the three reactions discussed, the amount and type of decay in an unknown sample of Douglas-fir can be determined usually within limits of 5 to 10%. The data have been compiled into a key in Table III to facilitate this determination.

Table II. Blends of Decayed and Sound-Wood Samples of Douglas-Fir Caustic-Treated Water Extract

Per cent blend used in sample	*Per cent blend converted to unground sample*	*Transmittance, %*
100 S_3	100 S_3	8
100 D_1	100 D_1	48
100 WP_2	100 WP_2	69
100 (Br + WP)$_1$	100 (Br + WP)$_1$	20
95 S_3— 5 (Br + WP)$_1$	92 S_3— 8 (Br + WP)$_1$	8
90 S_3—10 (Br + WP)$_1$	84 S_3— 16 (Br + WP)$_1$	8
85 S_3—15 (Br + WP)$_1$	77 W_3—23 (Br + WP)$_1$	8
95 S_3— 5 Br_1	85 S_3—15 Br_1	8
90 S_3—10 Br_1	73 S_3—27 Br_1	8
85 S_3—15 Br_1	63 S_3—37 Br_1	9
80 S_3—20 Br_1	55 S_3—45 Br_1	9
90 S_3—10 WP_2	90 S_3—10 WP_2	9
80 S_3—20 WP_2	80 S_3—20 WP_2	12
70 S_3—30 WP_2	70 S_3—30 WP_2	15
50 S_3—50 WP_2	50 S_3—50 WP_2	20
25 S_3—75 WP_2	25 S_3—75 WP_2	34
90 S_3—10 D_1	84 S_3—16 D_1	11
80 S_3—20 D_1	71 S_3—29 D_1	11
70 S_3—30 D_1	58 S_3—42 D_1	13
60 S_3—40 D_1	47 S_3—53 D_1	16
50 S_3—50 D_1	37 S_3—63 D_1	17
25 S_3—75 D_1	17 S_3—83 D_1	29

Notes: S—sound-wood sample. WP—white-pocket rot. D—dote rot. Br—brown rot. All rots are advanced stage rots.
[a] Run at wavelength of 490 mmu.

Table III. Wood Decay Key—Douglas-Fir

Extractive	*Std. No.*	*Transmittance,[a] %*	*Percentage advanced decay — White-pocket*	*Dote*	*Brown*
Alcohol	1A	...	0–10	0	0
	2A	...	10–20	5–10	Trace
	3A	...	25–30	15	<2
	4A	...	40–75	20–25	2
	5A	...	100	30–40	3
	6A	...	[b]	70–100	5
Water (untreated)	1B	...	0–25	0–20	0–10
	2B	...	25–50	25–35	15–20
	3B	...	75	40–65	25–40
	4B	...	100	80–100	45–60
Water (NaOH-treated)	...	<10	0–10	0–15	0–100
		11–15	20–25	30–40	0
		15–20	30–50	50–65	0
		20–25	50–60	70–75	0
		25–35	60–75	80–90	0

Through 100-mesh screen samples used for alcohol extractions. On 100-mesh screen samples used for water extractions.
[a] Run at wavelength of 490 mmu.
[b] The white-pocket rot would of necessity be in combination with another rot to match the standard no. 6A.

The presence of a preponderance of one type of decay is noted before the sample is pulverized and screened.

The alcohol extraction is carried out first. The standard matched by this extract establishes the possibility of a given amount of two or three types of decay according to Table III.

The water extraction is made next. Generally, the untreated water-extract standard matched will eliminate all but one of the types of decay. In some instances it may be helpful to determine the per cent transmittance of the NaOH-treated water extract to establish or eliminate the possibility of high percentages of dote or white-pocket rots in the original sample.

The key will determine the predominant type of decay except at low percentages of decay which normally are of small concern for pulpwood. For example, the filtrate from an alcohol extraction matched the standard no. 3A. This established the possible presence of 25 to 30% white-pocket, 15% dote, or a trace of brown rot (see Table III). The water extract matched standard no. 2B. From Table III the possible presence of 25 to 50% white-pocket, 25 to 35% dote, or 15 to 20% brown rots were indicated. By elimination, the unknown consisted of 25 to 30% white-pocket or possibly a combination of white-pocket and dote rots. The total would be not more than 30% of the original sample and would be primarily the white-pocket rot.

A large group of samples of chips from various sources were analyzed by this method. The samples were readily graded by means of the decay key in Table III. The test results of several samples revealed more decay than the first visual inspections had indicated. Careful chip-by-chip visual re-examinations of other portions of the same samples bore out the accuracy of the decay key.

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The Chemical Nature of the Extractives from White Fir Bark

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The extractive content of white fir bark ranged from 17 to 2[illegible]% of the dry weight of the bark. The hexane extractive, a light-brown wax obtained in about a 2.5% yield, was composed of free lignoceryl alcohol and behenic acid, and of combined lignoceryl alcohol, phytosterol, unsaturated alcohols, combined behenic acid, and unsaturated acids. Benzene extraction of the hexane-extracted bark residue produced a dark brown wax, in about a 1% yield, that was composed of lignoceryl alcohol, phytosterol, behenic acid, 3-hydroxy myristic acid, hexane-insoluble unsaturated acids, and a phenolic acid. By extracting this bark residue with ethyl ether, d-catechin, l-epicatechin, and 3′-methoxy dihydroquercetin were obtained in about a 2% yield. A phlobatannin was obtained in about a 7% yield by hot water extraction. Alcohol extraction of the solvent and water extracted bark residue yielded about 2% phlobaphene. The cork fraction, which comprised roughly 40% of the bark and was easily separable by screening hogged bark, contained 6% wax, 6 to 16% catechin, 5% tannin, and 3 to 7% phlobaphene.

White fir (*Abies concolor* Lindl. and Gord.) is one of the important softwood species found growing in nine western states. Its principal use is in the production of paper pulp; smaller amounts are used for general building construction, crating, and as a raw material for hardboard. Although the western pine region contains over 66 billion board feet of white fir stumpage, the present annual cut is only about 500 million board feet (*1*). This is due, in part, to its inferior strength properties and to increased difficulty in drying the lumber, in comparison to Douglas-fir, for example. As useful species, such as Douglas-fir and ponderosa pine, decrease in availability white fir undoubtedly will become increasingly important in lumber production.

At present, white fir bark is either disposed of in refuse burners or, more rarely, used as fuel. A study of the chemical constituents of the bark and their possible industrial utilization would have a twofold objective: the utilization of a waste material and the establishment of an additional source of income to the sawmill or the pulp mill operator. A survey of the literature showed that the only available information about this bark was a report on the nature and amount of volatile oils present (*2*). The present investigation was, therefore, undertaken to study the chemical constituents of the bark extractives and their potential uses.

RAW MATERIAL

An anatomical examination of white fir bark shows it to consist of several distinct components (see Fig. 1). The inner bark is light brown to reddish brown in color. It varies from $^1/_4$ to $1^1/_2$ in. in thickness and is composed of sieve cells, phloem parenchyma, and bast fibers. The outer bark varies from $^1/_2$ to 4 in. in thickness and consists of salmon-colored, corky layers interspersed with areas of dark red phloem tissue.

In order to determine the distribution of the extractives, a series of bark samples was taken separately from the bottom, middle, and top of trees of different ages. The collection data are shown in Table I. The samples were obtained from a mixed stand approximately 12 miles northeast of Fort Klamath, Ore., in July, 1950. The trees were felled 2 days prior to sampling. Bark samples were also obtained from the Lakeview Lumber Co. at Lakeview, Ore., and the Ivory Pine Lumber Co. at Dinuba, Calif.

PREPARATION OF THE SAMPLES

Within 24 hr. of the bark collection, it was reduced in a Mitts and Merrill hog to pass a 5-mesh screen. The hogged bark was air-dried to a moisture content of approximately 10% and then further reduced in size in a Rietz disintegrator to pass a 20-mesh screen. Equal parts of the bark from each section of each tree were mixed, giving nine composite samples representing the bottom, middle, and top sections of trees from three different age groups. After thorough air-drying, the samples were stored in glass jars.

A method for the separation of the cork and the bark phloem was developed in order to determine the extractive content of these components. Pure analytical samples of cork and phloem could be obtained by splitting off the inner bark by hand and then purifying the cork by a previously described, alternate grinding and screening process (*2*). This procedure is slow and would be impractical from an industrial standpoint.

On a large scale, it was found that reasonably good separation could be achieved by first air-drying the bark to about 15% moisture content and then passing it through a hog equipped with a $^1/_2$-in. screen. This material was screened through a 20- and a 100-mesh sieve. The fraction retained on the 20-mesh sieve represented about 40% of the bark by weight and contained 90% cork. The fraction retained on the 100-mesh screen represented about 55% of the bark by weight and consisted of bark phloem admixed with about 20% cork. The fraction passing through the 100-mesh sieve was composed of broken phloem, cork, etc., and represented about 5 to 10% of the bark.

DISTRIBUTION OF THE EXTRACTIVES

The bark samples were successively extracted with hexane, benzene, diethyl ether, hot water, and ethanol.

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Table I. Collection Data on White Fir Bark Samples

Age group no.	Average age, yr.	Tree age, yr.	Bottom section, diameter of bark, in. Outside	Bottom section, diameter of bark, in. Inside	Middle section, diameter of bark, in. Outside	Middle section, diameter of bark, in. Inside	Top section, diameter of bark, in. Outside	Top section, diameter of bark, in. Inside
			(2.0 to 3.5 ft. height)		(20 to 30 ft. height)		(40 to 60 ft. height)	
I	116	123	30	27	22.5	21	16	15
		105	29	26	22.0	20	16	15
		120	27.5	24	20.5	19	15	14
			(2.0 to 3.5 ft. height)		(40 to 50 ft. height)		(80 to 90 ft. height)	
II	152	167	40.0	37	23.5	22	16	15
		146	38.0	35	22.5	21	15	14
		143	34.5	31.5	19	18	16	15
			(2.0 to 3.5 ft. height)		(50 to 55 ft. height)		(100 to 110 ft. height)	
III	209	226	43	39	31.5	29	20	19
		194	37.5	34	28	26	18	17

The nature of the material removed by each of these solvents is shown in Table II.

Table II. Nature of White Fir Bark Extractives

Solvent	Extractives
Hexane	Light brown wax
Benzene	Dark reddish-brown wax
Ethyl ether	d-Catechin and l-epicatechin
Hot water	Tannin and carbohydrates
Ethanol	Phlobaphene

Thirty-five grams of each of the nine samples, with known moisture content, were placed in cloth bags and extracted successively with hexane, benzene, and ether in borosilicate glass, Soxhlet extractors. Each extractive was then dried to constant weight in a vacuum oven at 55°C. The hot-water solubility was determined by extracting the solvent-extracted residues in Erlenmeyer flasks with four successive 500-ml. portions of hot water over a period of 4 hr. A 250-ml. aliquot of the aqueous extract was evaporated to dryness and weighed. The hot-water extracted bark was then air-dried and subsequently extracted with ethanol in a Soxhlet extractor. All determinations were made in duplicate.

The distribution of the extractives in the nine composite samples is shown in Table III. Although the total extractive content does not markedly vary between the samples, there are significant differences among the individual extractives. In young trees, the hot-water solubility is considerably higher in samples obtained from the tops. The sum of the hexane, benzene, and ether extractives increases with increasing age of the tree. This extractive distribution pattern is similar to that in Douglas-fir bark (*4*).

The distribution of the extractives among the various bark fractions is shown in Table IV. These fractions were obtained from the bottom bark of trees in age group III. Comparison is made with extractives from a sample of white fir wood obtained from the bottom of trees of approximately the same age. The bark cork fraction was found to contain the greatest amounts of hexane, benzene, and ether-soluble components. The yield of the extractives from cork obtained from the barks of trees of different ages is shown in Table V. The percentage of hexane, benzene, and hot water-soluble extractives shows small variation. The percentage of ether-extractive and the alcohol-extractive, however, markedly increases with age of the tree. Similar behavior was noted in the case of Douglas-fir cork (*3*).

CONSTITUENTS OF THE EXTRACTIVES

Hexane Extract

This extract is a moderately hard wax, ranging in color from light brown to a cream. It was obtained by direct extraction of the whole bark or bark fractions with Skellysolve B, a petroleum fraction with a boiling point of 60 to 70°C. The extract was evaporated to dryness and then steam distilled to remove volatile oils. The volatile oils were not further examined, since they have been previously characterized (*1*) and the yields were relatively small (usually less than 0.3% by weight of the bark). The yields and properties of this wax are shown in Table VI.

Table IV. Percentage Extractives from White Fir

Values Based on Oven-Dry Weight of Material

Solvent	Wood	Inner bark	Outer bark phloem	Cork
Hexane	0.20	0.53	1.23	3.46
Benzene	0.03	0.19	0.52	1.93
Ethyl ether	0.12	0.07	1.28	8.98
Hot water	2.11	12.74	10.47	7.69
Ethanol	3.12	0.98	1.90	3.89
Sum of five extractives	5.58	14.51	15.40	25.95

Table III. Percentage Extractives from White Fir Bark

Values Based on Oven-Dry Weight of Material

Age group	Position on tree	Solvent: Hexane	Benzene	Ether	Hot water	Ethanol	Sum of five extractives
I	Top	2.14	0.78	0.41	14.45	0.67	18.45
	Middle	2.44	0.92	1.02	13.54	1.95	19.87
	Bottom	2.91	1.02	1.63	9.85	2.84	18.25
II	Top	2.10	1.03	0.93	15.67	0.98	20.71
	Middle	1.30	0.70	0.59	12.83	1.65	17.07
	Bottom	2.44	0.69	1.94	15.14	2.70	22.91
III	Top	2.46	0.89	2.79	11.43	2.31	19.88
	Middle	2.61	1.00	3.42	10.98	2.09	20.10
	Bottom	2.72	1.10	3.80	10.61	3.31	21.54

Table V. Percentage Extractive from White Fir Cork

Values Based on Oven-Dry Weight of Material

Solvent	Average age of trees: 152	209	241[a]
Hexane	4.03	3.46	4.50
Benzene	2.03	1.93	2.07
Ether	5.93	8.98	16.62
Hot water	7.64	7.69	6.86
Ethanol	3.13	3.89	7.21
Sum of five extractives	22.76	25.95	37.26

[a] Bark from Ivory Pine Lumber Co.

The chemical constituents from a wax sample representative of the whole bark were separated and isolated by the procedure shown in Fig. 2. Fifty grams of wax were dissolved in 150 ml. of hot acetone, and the solution was cooled to 35°C. A white precipitate of uncombined, fatty alcohols, I, was rapidly filtered off with suction, and the filtrate evaporated to dryness. This residue was dissolved in ether and extracted with 5% potassium carbonate in order to remove free acids, II. The neutral fraction, which remained in the ether layer, was evaporated to dryness and then saponified for 2 hr. with 300 ml. of 2 *N* alcoholic potassium hydroxide. The alcohol was removed by boiling, replaced with water, and the resultant aqueous solution extracted with ether to remove the unsaponifiables, III. The aqueous soap solution was acidified with hydrochloric acid and extracted with ether to remove the combined acids. No constituents were found in the residual aqueous layer. The yields of the various constituents are shown in Table VII.

Uncombined Alcohol, I. The white, crystalline precipitate, I, was purified by several recrystallizations from hot acetone. The resulting, white, crystalline solid melted at 68 to 69°C., gave no test for unsaturation and a negative Liebermann-Burchard test for sterols.

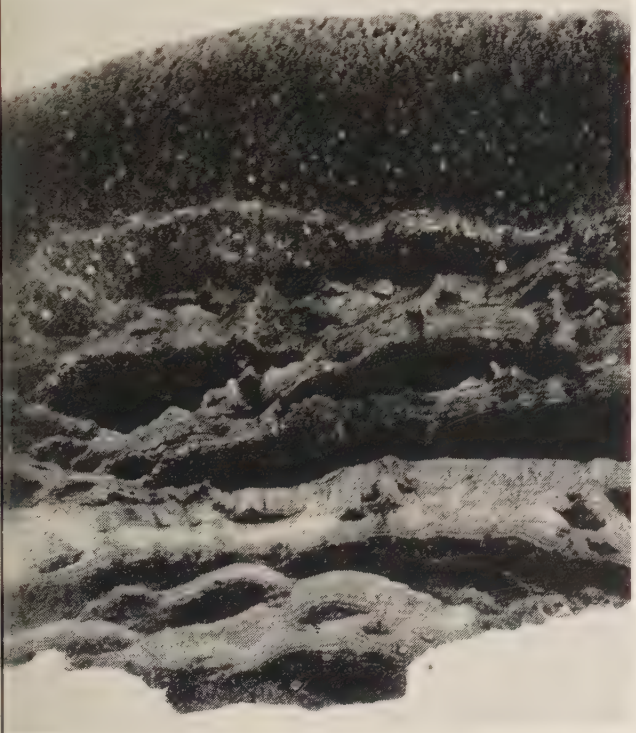


Fig. 1. Cross section of white fir bark from the butt of a 150-year-old tree

Table VI. Properties of Hexane-Soluble Wax from White Fir Bark

Bark fraction	Whole bark	Cork	Cork-free bark
Color	Yellow-brown	Cream	Brown
M.p., °C.[a]	52–53	56–57	47–48
Yield (O.D. basis), %	2–3	3–6	0.5–1.5
Unsaponifiables, %	37.8	39	30.6
Acid number	61	53	74
Saponification number	113	107	136

[a] Fisher-Johns melting point block.

An acetate derivative, melting point 51 to 52°C., was prepared with pyridine and acetic anhydride. These properties suggested that the material was a saturated, aliphatic alcohol, a conclusion that was verified by oxidizing the alcohol to the corresponding acid by a potash fusion (*5*). Extraction of the alkaline fusion mixture with ether yielded only traces of ether-soluble material, indicating the absence of hydrocarbons in this fraction. The fusion mixture was acidified with hydrochloric acid, and the liberated acids recrystallized from acetone. They melted at 71 to 72°C. and had a neutral equivalent of 364. These properties correspond to those of a mixture of lignoceric acid and near homologs, indicating the original alcohol to be lignoceryl alcohol. A mixed melting point with the lignoceryl alcohol from Douglas-fir bark hexane wax (6) was undepressed.

Free Acids, II. The potassium soaps of the free acids were acidified with hydrochloric acid. The liberated free acids were filtered off, dried, and then recrystallized three times from acetone. A white, microcrystalline product was obtained with a melting point 70 to 71°C., and neutral equivalent of 346. A negative test for unsaturation was obtained with bromine water, and also with potassium permanganate solution. These properties suggest that the product was a mixture of behenic acid and near homologs.

The filtrates from the acetone recrystallizations were combined and evaporated to dryness. The residue comprised a small amount of a sticky, semiliquid mixture of acids that gave positive tests for unsaturated acids, but a negative Liebermann-Storch test for resin acids. Since oxidation with cold alkaline permanganate (*7*) yielded no crystallizable products, this fraction was not further characterized.

Unsaponifiable, III. The neutral fraction remaining after the separation of free alcohols and acids was a cream-colored wax with a melting point of 54°C. It was saponified for 3 hr. with 2 *N* alcoholic potassium hydroxide. The alcohol was replaced with water, and the aqueous soap solution was extracted with ether in a separatory funnel in order to remove the unsaponifiable fraction. The ether extract was washed with 5% sodium carbonate solution and water. After drying

Table VII. Percentage Constituents of Hexane-Soluble Wax from White Fir Bark

Values Based on Oven-Dry Weight of Wax

	Whole bark	Cork	Cork-free bark
Lignoceryl alcohol	34.7	36.7	27.5
Sterol and unsaturated alcohols	3.1	1.8	5.1
Free acids	36.5	32.3	42.5
Behenic acid	31.2	30.0	30.3
Unsaturated acids	5.3	2.3	12.2
Combined acids	23.5	26.8	20.6
Behenic acid	19.0	24.4	12.4
Hexane-insoluble acids	4.5	2.4	8.2
Loss (by difference)	2.2	2.4	4.3

over sodium sulphate, the solution was evaporated and yielded a cream-colored residue that was separated into three components by fractional crystallization from hot acetone.

The first, and largest, fraction, obtained by solution of the residue in a large volume of hot acetone and recrystallization at room temperature, was a white, crystalline, saturated alcohol with a melting point of 68.5 to 69.5°C. (cor.). A mixed melting point with the free wax alcohol was undepressed. Oxidative fusion with potash yielded a crystalline acid with a melting point of 71 to 72°C. and a neutral equivalent of 365. These properties indicated that the alcohol belonged to the lignoceryl series and that it was identical with the free wax alcohol.

When the filtrates from the preceding crystallization were concentrated to a small volume and cooled in an icebox, long, needle-shaped crystals were formed, that had a melting point of 134 to 135°C. and gave a positive Liebermann-Burchard test for sterols. A mixed melting point with Douglas-fir wood phytosterol (*8*) was undepressed. The filtrate from the sterol separation was evaporated to dryness and yielded a yellow-orange sticky residue that gave a positive test for unsaturation. It was not further characterized.

Combined Acids, IV. The aqueous soap solution remaining after the separation of the unsaponifiables was acidified with hydrochloric acid and extracted with ether. The ether extract of liberated acids was washed with water and then dried over sodium sulphate. The solvent was removed by evaporation, and the acids were crystallized from hot hexane and then from acetone. A white, crystalline acid was obtained, which had a melting point of 70.5 to 71.5°C., a neutral equivalent of 344, and gave no test for unsaturation. A mixed melting point with the crystalline free acid was undepressed, indicating the two acids to be identical, and to consist essentially of behenic acid. The filtrates from the preceding crystallizations, after being evaporated to dryness, yielded a dark-colored, sticky residue, that had a melting point of about 40°C., and was not crystallizable from any of several solvents. This fraction was not further characterized.

Benzene Extract

This fraction, a hard, reddish-brown wax that softened at 70 to 72°C., was obtained by extracting the hexane-extracted bark residue with benzene. It was very soluble in benzene, dioxane, and ethyl acetate; moderately so in acetone, methanol, and ethanol; and sparingly soluble in ether. It could not be crystallized nor separated into simpler components by the use of any of these solvents. The wax was insoluble in either cold sodium bicarbonate, sodium carbonate, or sodium hydroxide solutions, indicating the absence of free acids or acidic groupings.

Preliminary investigation showed the wax to be an ester of aliphatic acids, aliphatic hydroxy acids, and a phenolic acid, similar to the hexane insoluble wax in Douglas-fir bark (*3*). The wax was separated into simpler components by saponification, following the scheme shown in Fig. 3. Forty grams of wax were

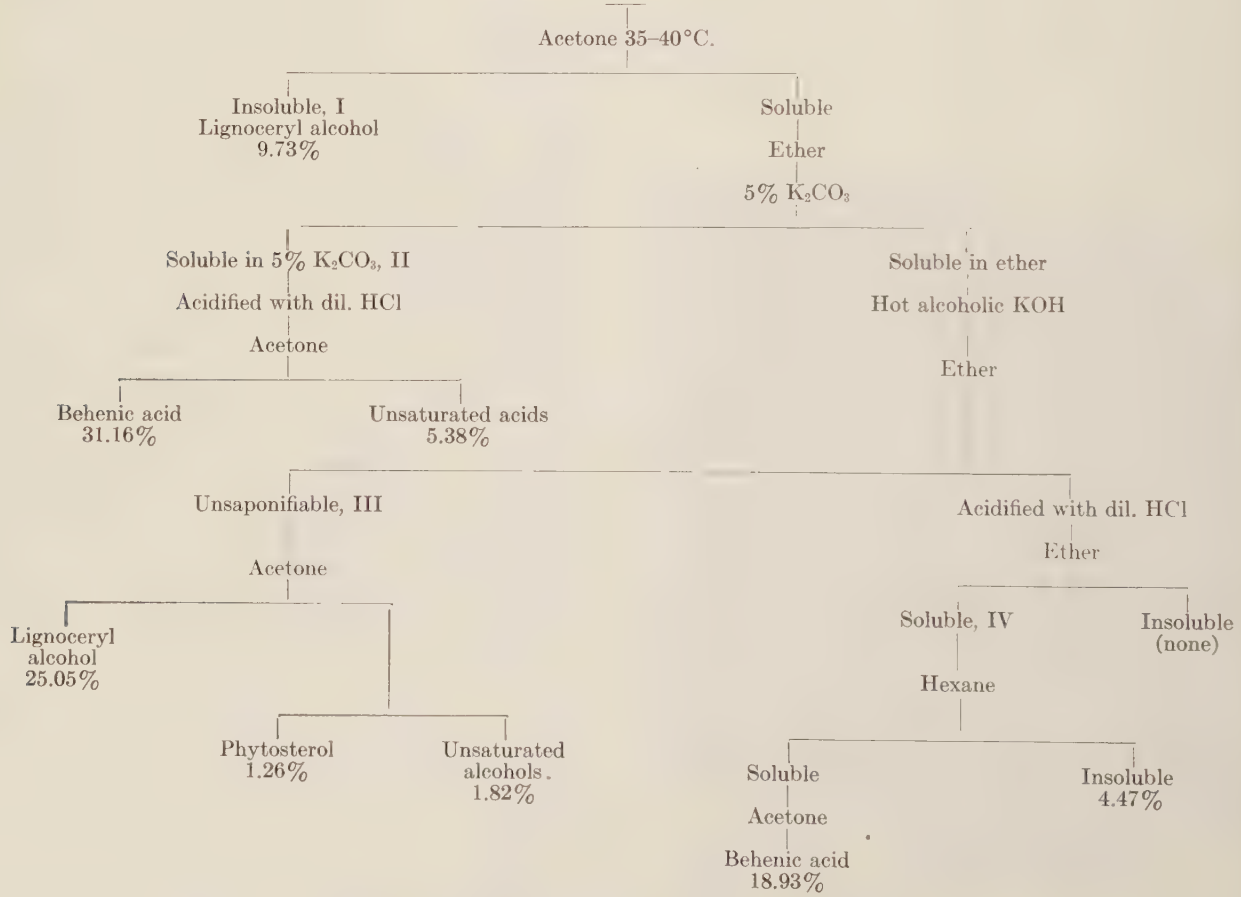


Fig. 2. Separation of components of hexane-soluble wax
Percentages based on oven-dry weight of wax.

saponified for 3 hr. in 300 ml. of 40% ethanol containing 25 grams of potassium hydroxide. Saponification was carried out in this medium because the phenolic acid formed a potassium salt that was insoluble in alcohol but soluble in water. The dilute alcohol solution, therefore, permitted saponification to take place in a homogeneous system.

After saponification, the mixture was boiled to remove ethanol, and the aqueous solution extracted with ether to remove the unsaponifiable fraction. The aqueous soap solution was acidified with hydrochloric acid. The resultant precipitate was filtered off and washed with water to remove mineral acid. After thorough air-drying, the precipitate was placed in a paper thimble and successively extracted with hexane, benzene, and absolute ether in a Soxhlet extractor. The mother liquor and the washings from the acid precipitation were combined, neutralized, and evaporated to dryness *in vacuo*. A small amount of ether-insoluble phenolic acid was recovered in this way. Neither glycerol nor any other organic compounds were detected in this residue.

Unsaponifiables, I. The unsaponifiable faction was recrystallized several times from acetone. A white crystalline alcohol, melting point 68 to 69°C., was obtained which, upon oxidative fusion with KOH, yielded an aliphatic acid with a melting point of 69 to 71°C. and a neutral equivalent of 368, indicating that the original alcohol was lignoceryl alcohol. A mixed melting point with the lignoceryl alcohol from the hexane wax was undepressed. Evaporation of the filtrates from the recrystallizations yielded small amounts of a phytosterol, melting point 134 to 135°C., and unsaturated materials that were similar to those isolated from the hexane-soluble wax.

Hexane-soluble Acids, II. This fraction consisted of a saturated aliphatic acid and a hydroxy aliphatic acid. Their separation was based on the relative insolubility of the hydroxy acid in hexane at 25°C. and the relative insolubility of the saturated acid in acetone at 25°C. The mixture (20 grams) was dissolved in 750 ml. of hot hexane, and the solution cooled to room temperature. The precipitated hydroxy acid, IIb, was filtered off and washed with hexane. The mother liquor and washings were combined and evaporated to dryness. The residue was dissolved in hot acetone, a white precipitate was obtained upon cooling. After several recrystallizations from acetone, the acid, IIa, melted at 70 to 71°C. and had a neutral equivalent of 346. The melting point was undepressed upon admixture with the behenic acid from the hexane-soluble wax.

The hydroxy acid, IIb, was purified by resaponification in alcoholic potassium hydroxide and subsequent acidification. After recrystallization from hexane, it melted at 81 to 82°C. (cor.) and had a neutral equivalent of 246.0. Contact with heat or mineral acids caused etholide or lactone formation with a consequent lowering of the melting point and an increase in the neutral equivalent value.

The hydroxy acid was methylated with dimethyl sulphate and KOH in 50% alcoholic solution. A large excess of dimethyl sulphate was used and the solution kept basic. The methylated acid was refluxed in alcoholic potassium hydroxide to decompose any methyl ester present, acidified, and recrystallized from hexane. It melted at 67 to 68°C., had a neutral equivalent of 259.5, and contained 11.9% methoxyl. These properties corresponded to a mono-methoxy myristic acid, $C_{15}H_{30}O_3$, with a calculated neutral equivalent of 258.3 and a methoxyl content of 12.0%, indicating

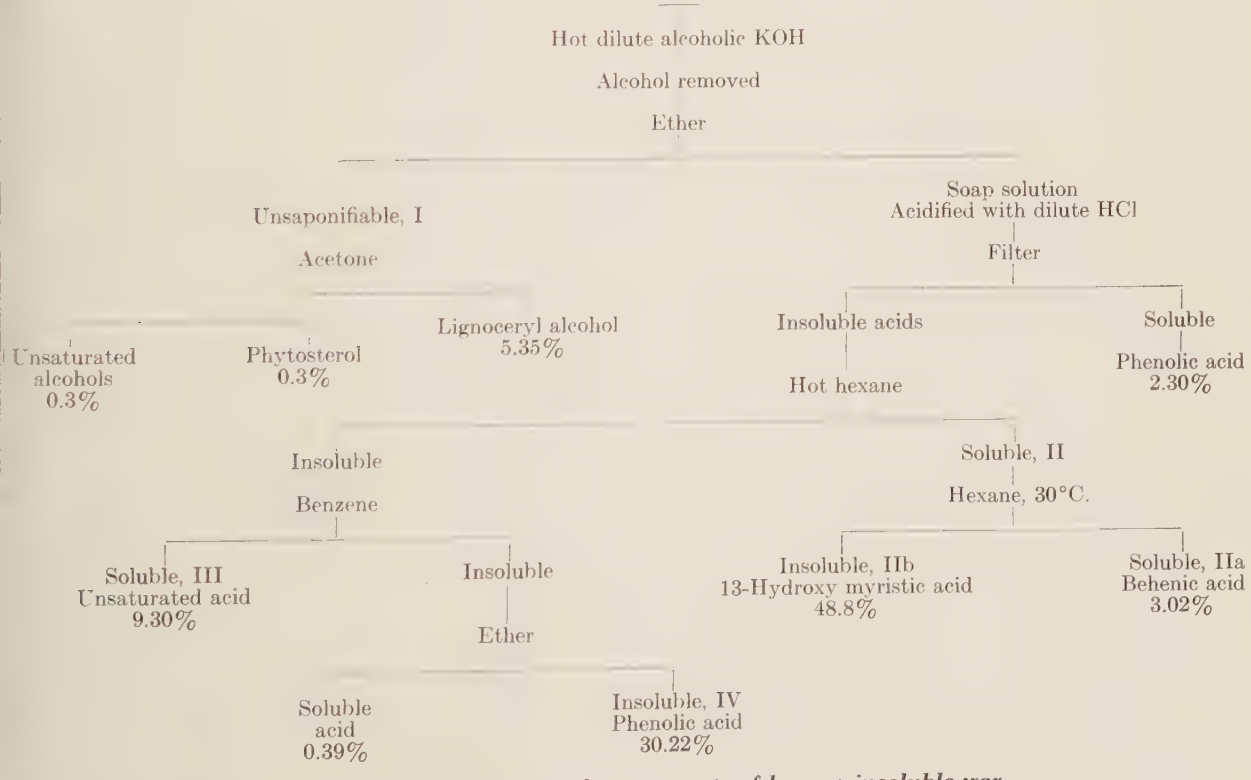


Fig. 3. Separation of components of hexane-insoluble wax
Percentages based on oven-dry weight of wax.

that the original material was a mono-hydroxy myristic acid.

Fusion of the hydroxy acid with potassium hydroxide at 325°C. for 30 min. produced a small yield of a dicarboxylic acid, that could be separated from unchanged hydroxy acid by its insolubility in hexane. It had a melting point of 111°C., a neutral equivalent of 119, and a molecular weight of 240 by the Rast method. These properties indicated that the hydroxyl group was attached to the 13 carbon atom and that the original acid was 13-hydroxy myristic acid. A literature search showed this to be the first reported isolation of this acid from natural or synthetic sources. Previously prepared mono-hydroxy myristic acids are the 2-, 3-, 11-, and 14-hydroxy acids (*9*), all of which have been obtained synthetically.

Benzene-Soluble Acids, III. The benzene-soluble (hexane-insoluble) fraction was purified by resaponification and acidification. A mixture of light-brown sticky acids, melting point 35 to 45°C., was obtained that could not be crystallized from a variety of solvents. The ether-soluble acid fraction also was a dark sticky mixture. Neither fraction was further characterized.

Ether-Insoluble Acid, IV. This fraction was purified by dissolving in dioxane and precipitating in water. It was then redissolved in a minimum amount of dioxane and precipitated in absolute ether. The precipitate, a brown powder, was soluble in ethanol, methanol, dioxane, aqueous sodium hydroxide or sodium carbonate, sparingly soluble in acetone, only slightly soluble in sodium bicarbonate, and insoluble in ether, benzene, or hexane. An alcoholic solution gave a greenish-brown color with 1% ferric chloride solution.

The infrared spectra of this fraction and its methylated derivative (prepared by treatment with diazomethane) are shown in Fig. 4. A model 12-c Perkin-Elmer spectrometer, equipped for double-beam operation, was used to obtain the spectra. The samples were mulled in Nujol or perfluorokerosene and run against a salt plate as a blank. Table VIII shows the tentative absorption band assignments and a comparison with the tannin, phobaphene, and methylated phlobaphene fractions from white fir bark.

Examination of the spectra indicates the presence of a carbonyl group which from its position (1703 cm.$^{-1}$) could only be an aliphatic aldehyde, ketone, or carboxyl group. The shift to higher frequency upon methylation indicates that this band is due to a carboxyl group,

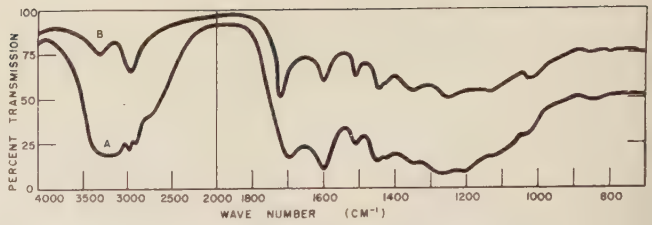
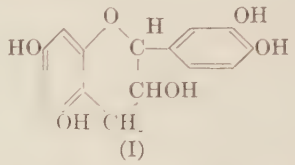


Fig. 4. Infrared spectra of A—ether insoluble acid IV, B—IV methylated with diazomethane

since methyl esters show a shift of 10 to 30 cm.$^{-1}$ from the unsubstituted carbonyl position. A close similarity to the spectra of phlobaphene (Fig. 5) was observed. This band was much more intense than the corresponding band in the phlobaphene, however, and a higher percentage of carboxyl in the phenolic acid is indicated.

Ether Extract

The ethyl ether extract was found to consist principally of d-catechin, I, melting point 176 to 177°C., and its *cis* modification, l-epicatechin, melting point 245°C. (*10*). These compounds were identified by



(I)

their acetate derivatives, optical rotation, x-ray diffraction patterns, and a comparison of their infrared spectra with authentic compounds. Catechin was found to be present in a ratio of approximately 10 parts to 1 of epicatechin.

A third component of the ether extract, present in extremely small amounts (0.07% of the total extract) was obtained by boiling for 8 hr. an aqueous solution of the crude extract containing 10% by weight of sodium bisulphite. During this time, a yellow, flocculent precipitate of 3′-methoxy quercetin, melting point 305°C., was formed. This colored, water-insoluble compound is not found in the original extract but presumably originates from 3′-methoxy-dihydroquercetin, the conversion to the flavone being effected by the sodium bisulphite (*11*). The conversion of flavanones to flavones by sodium bisulphite appears to be limited to 3-hydroxy flavanones. The original extract gave positive

Table VIII. Infrared Absorption Bands of White Fir Tannin, Phlobaphene, and Wax Phenolic Acid

Assignment	*Wave number (cm.$^{-1}$)*				
	Tannin	*Phlobaphene*	*Methylated phlobaphene*	*Phenolic acid*	*Methylated phenolic acid*
Hydroxyl	3300	3320	3490	3230	3390
CH_2 or CH_3	2925	2925	2950	2950, 2890	2950
Carbonyl	...	1701	1718	1696	1720
Phenyl rings	1603	1608	1599	1602	1598
	1514	1513	1513	1512	1512
—C—H—	1451	1447	1458	1450	1455
	1352	1350	1422	1420	1355
	...	...	1355	1350	...
Unassigned	1283	1275	1263	1270	1260
	1195	1200	1199	1200	...
	1102	...	1122	1125	1144
	980	1036	1025	1035	1027
	860	860	861	860	860
	808	792	800	...	790
	724	...	748	...	...
	...	...	720	...	...

Table IX. Effect of Time on Tannin Extraction of White Fir Bark

Percentages Based on Oven-Dry Weight of Bark

	Time of extractions, hr.				
	1¼	2	3	6	9
Total solids, %	11.21	12.53	12.87	14.33	14.57
Insoluble solids, %	0.06	0.34	0.59	0.64	2.67
Soluble solids, %	11.15	12.19	12.28	13.69	11.90
Tannin, %	6.26	6.73	6.92	7.40	5.57
Nontannin, %	4.89	5.46	5.36	6.29	6.33
Tannin/sol. solids ratio	0.562	0.552	0.562	0.541	0.468

tests for a 3-hydroxy flavanone with zinc and hydrochloric acid (*12*); attempts to isolate the original flavanone, however, were unsuccessful, possibly because of solubility characteristics similar to those of catechin and because of the exceedingly small amount present.

Tannin

Tannin analyses on air-dry, white fir bark were carried out by the American Leather Chemists Association method (*13*). In order to ascertain the optimum tannin extraction time, a series of hot-water extractions were made in which the length of extraction time was varied. The middle section bark sample of age group II was selected for these extractions. As can be seen from the results in Table IX, a 6-hr. extraction period gave optimum tannin yields. This period, therefore, was used for the determination of tannin distribution by age group and location on the tree; the results of these analyses are shown in Table X. The bottom bark from the oldest trees had the highest tannin content, whereas the top bark from young trees had the highest.

Since the distribution of tannin among the various bark fractions might prove of interest, it is shown in Table XI. The fractions were obtained by separation

Table XI. Tannin Distribution in White Fir Bark Fractions

Percentages Based on Oven-Dry Weight of Bark

Sample	Inner bark	Outer bark phloem (cork-free)	Cork
Total solids, %	14.31	12.06	18.43
Soluble solids, %	12.88	10.00	17.43
Insoluble solids, %	1.43	2.06	1.00
Tannin, %	7.19	5.48	10.70
Nontannin, %	4.69	4.52	6.73
Tannin/sol. solids ratio	0.55	0.54	0.61

from the bottom bark of age group III. The analyses indicate that the cork fraction has the highest tannin content and also gives the extract with the highest degree of purity (ratio of tannin to soluble solids).

The stand of trees from which these samples were obtained was quite dense and contained some trees of small diameter. These trees were as old as those of larger diameter, but apparently had been suppressed by the density of the stand. A comparison of the tannin content of the bark of such trees with that of larger diameter trees is shown in Table XII. Although the tannin content of the bark from small trees is somewhat lower, it is still sufficiently high for commercial extraction.

Table XII. Effect of Tree Diameter Upon Tannin Distribution in White Fir Bark

Percentages Based on Oven-Dry Weight of Bark

Average age, yr.	143	152
Average diameter, in.	9	35
Average thickness of bark, in.	5/8	1 1/2
Distance of sample from tree base, ft.	2–6	2–3 1/2
Total solids, %	15.26	17.12
Soluble solids, %	14.54	15.37
Insoluble solids, %	0.72	1.75
Tannin, %	7.53	10.01
Nontannin, %	6.91	5.36
Tannin/sol. solids ratio	0.518	0.651

An examination of the nontannins indicated the presence of catechin. The boiling of catechin solutions, however, especially in the presence of tannins, appeared to cause some change in the catechin nucleus that made it partially absorbable on hide powder. This was evidenced by a study of the tannin extract from both the unextracted and ether-extracted white fir barks. The top and bottom barks from a tree with an approximate age of 210 yr. were analyzed; the analyses are given in in Table XIII.

Table X. Analysis of Tannin Extracts from White Fir Bark

Percentages Based on Oven-Dry Weight of Bark

Age group	Sample	Total Solids, %	Soluble solids, %	Insoluble solids, %	Tannin, %	Nontannin, %	Tannin/sol. solid
I	Top	17.42	14.76	2.66	6.96	7.80	0.47
	Middle	12.18	11.44	0.69	6.18	5.26	0.54
	Bottom	12.53	10.94	1.59	6.26	4.68	0.57
II	Top	17.85	16.50	1.35	8.82	7.68	0.53
	Middle	14.33	13.69	0.64	7.40	6.29	0.54
	Bottom	17.12	15.37	1.75	10.01	5.36	0.65
III	Top	13.04	12.14	0.90	6.31	5.83	0.52
	Middle	12.30	11.45	1.85	6.30	5.15	0.55
	Bottom	17.58	16.29	1.29	10.17	6.12	0.62

Table XIII. Tannin Analysis of White Fir Bark Before and After Ether Extraction

Percentages Based on Oven-Dry Weight of Unextracted Bark

Sample	Unextracted top bark	Ether-extracted top bark	Unextracted bottom bark	Ether-extracted bottom bark
Ether-soluble (catechin), %	1.97	...	4.75	...
Total solids, %	15.46	12.86	17.92	11.79
Soluble solids, %	14.91	12.54	17.25	10.74
Insoluble solids, %	0.55	0.32	0.67	1.05
Tannin, %	8.70	8.68	10.49	7.85
Nontannin, %	6.21	3.86	6.76	3.89
Tannin/sol. solids ratio	0.584	0.692	0.608	0.689

The data in Table XIII indicate that the purity of the tannin extract was markedly increased when ether-extracted (catechin-free) bark was used. This result suggested a procedure which gave a tannin extract with increased purity, and at the same time, a good yield of catechin. White fir bark, preferably the cork fraction, was extracted with hot water. The hot-water extract was evaporated to about 5% total solids content, and a small amount of sodium bisulphite was added to prevent the tannin from acting as a colloidal dispersant of the catechin. After standing 12 hr., catechin had precipitated from the dark red solution and was filtered off. One recrystallization from hot water yielded pure d-catechin. The filtrate contained tannin with a purity ranging from 60% for the whole bark to 75% for the cork fraction.

In general, the tannin from white fir bark is light reddish-brown in color and appears to be of good quality. A well-plumped, pliable, light reddish-brown leather resulted when a sheepskin skiver was tanned with an aqueous solution of the tannin. The tannin belongs to the phlobatannin classification, since it gave an emerald-green color with ferric chloride solution, and precipitated phlobaphene "reds" when boiled with mineral acids. It appeared much more stable under heat than Douglas-fir tannin; most of the tannin was still water soluble after the dried extract had been heated for 6 hr. at 105°C.

Phlobaphene

Ether-extracted bark was extracted with 95% ethanol for 8 hr. in a large, Soxhlet-type extractor. When the alcohol extract was concentrated to a syrup and poured into water, a voluminous red precipitate was obtained that was filtered off and washed with water to remove any adsorbed tannin. The precipitate was twice reprecipitated in water and then purified further by being dissolved in a minimum amount of dioxane and reprecipitated in absolute ether. A salmon-colored, amorphous powder, decomposing at about 275°C., was obtained; it gave a bright green coloration with alcoholic ferric chloride solution. The infrared spectra of this material and of a derivative prepared by treatment with ethereal diazomethane are shown in Fig. 5.

The aqueous filtrate from the phlobaphene precipitation was concentrated, *in vacuo*, to a solution with a total solids content of about 5%. This was poured into a saturated salt solution to precipitate the tannin, which was then filtered off by suction and dried in a desiccator. An analysis of the precipitated tannin by the hide powder method showed a purity of 93%. Other procedures such as lead precipitation, or adsorption on hide powder and subsequent recovery with alcohol gave a less pure tannin.

The infrared spectrum of the tannin is shown in Fig. 5, and the absorption band assignments in Table VIII. Comparison of the curve with that of phlobaphene shows marked dissimilarities. The greatest difference is in the presence of the carbonyl band (presumably due to a carboxyl group, since methylation shifts it to a position out of the range of aldehydes and ketones, but normal to esters) and a pronounced band attributable to CH_2 or CH_3 groups in the phlobaphene. Both of these bands are absent from the tannin spectrum and, furthermore, do not appear there after the

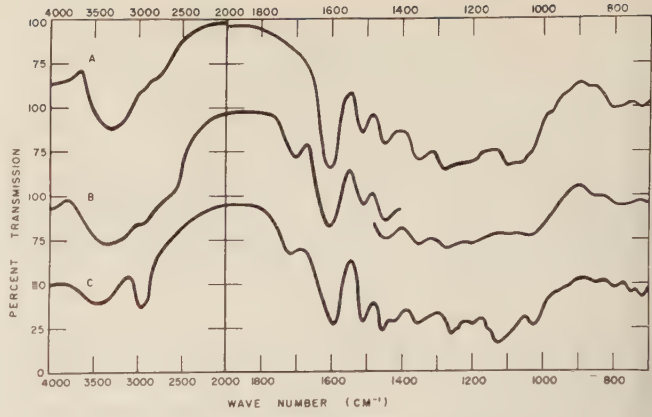


Fig. 5. Infrared spectra of A—white fir tannin, B—white fir phlobaphene, C—phlobaphene methylated with diazomethane

tannin has been "condensed" by the action of acid or by long boiling. This indicates that the tannin molecule does not give rise to the phlobaphene in the bark by the simple process of condensation. On the contrary, the marked similarity of the phlobaphene to the wax phenolic acid and to the bark "lignin" or phenolic acid, both in spectra and properties, suggests that the phlobaphene bears the same relationship to the bark "lignin" that Brauns' native lignin (*14*) bears to wood lignin.

Carbohydrate

A crude carbohydrate fraction was isolated by concentrating the hot-water extract from ether-extracted bark *in vacuo*, and then pouring the syrup into ethanol. The flocculent precipitate was filtered off and dried in a desiccator. A yield of 0.4% was obtained from cork and one of 2.3% from the inner bark of age group III. The crude carbohydrate material was purified by treating an aqueous solution with hide powder to remove occluded tannin and then reprecipitating the carbohydrate in ethanol. A light tan powder was obtained which gave 83% reducing sugar after acid hydrolysis. A conventional sugar determination on the acid-hydrolyzed hot water extracts of cork and inner bark yielded 0.9 and 3.3% reducing sugar (calculated as glucose), respectively. The individual sugars were not characterized.

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ASSOCIATION NEWS AND EVENTS

Local Section Meetings

Pacific: May 22–23, 1953, at the Gearhart Hotel, Gearhart, Ore. Annual joint meeting with the Pacific Division of the Superintendents Association.

Lake States: April 15, 1953, at the Elks Club, Wisconsin Rapids, Wis. Discussion "Fourdrinier Operation and Paper Defects Attributable to Such Operation." Visit to the mill of The Nekoosa-Edwards Paper Co., Port Edwards, Wis.

Delaware Valley: March 26, 1953, at the Engineers Club, Spruce Street, Philadelphia, Pa. John R. Curtis of the Scott Paper Co., Chester, Pa., will discuss "Increased Production from Existing Machines." April 23, 1953, at Philadelphia, panel discussion on "Paper Defects," led by L. P. Thompson, Personal Products Corp., Milltown, N. J.

Kalamazoo Valley: April 2, 1953, at the Hotel Harris, Kalamazoo, Mich. Discussion of "Rosin, Starch and Synthetic Chemical Sizing." May 7, 1953, at Kalamazoo, Western Michigan College Night. Presentation of summaries of senior student theses on pulp and paper subjects.

New England: June 19–20, 1953, at the Poland Spring House, Poland Spring, Me. Joint meeting with The Maine-New Hampshire Section.

Ohio: April 9, 1953, at Springfield, Ohio. Inspection tour of plants of Bauer Bros. Co. and the Crowell-Collier Publishing Co.

Empire State: June 8–10, 1953, at Whiteface Inn, Lake Placid, N. Y.

Empire State Northern District: April 9, 1953, at the Woodruff Hotel, Watertown, N. Y. "Recent Developments in Paper Machine Drives," by S. E. Franklin, Westinghouse Electric Corp., Pittsburgh, Pa.

Empire State Central District: April 3, 1953, at the University Club, Syracuse, N. Y. Speaker: Fred G. Sommerville, Armstrong Cork Co., Fulton, N. Y. May 1, 1953, at the University Club, New York State College of Forestry Night. Speaker: R. G. Macdonald, TAPPI, New York, N. Y.

Empire State Eastern District: April 16, 1953, inspection tour of the mills of the United Board & Carton Co., Schuylerville, N. Y., and The Stevens & Thompson Co., Greenwich, N. Y.

Empire State Western District: April 1, 1953, at the Park Hotel, Lockport, N. Y. Annual meeting.

Maine-New Hampshire: June 19–20, 1953, at Poland Spring House, Poland Spring, Me. Joint meeting with the New England Section.

Lake Erie: April 17, 1953, at the Hotel Carter, Cleveland, Ohio. Discussion: "General Maintenance for the Converter."

Southeastern: May 8, 1953, at the De Soto Hotel, Savannah, Ga.

Canadian Pulp and Paper Association, Technical Section: June 4–6, 1953, at the Saranac Inn, Saranac, N. Y.

American Pulp and Paper Superintendents Association: June 9–11, 1953, at the Atlanta-Biltmore Hotel, Atlanta, Ga. Annual meeting.

Report of Secretary

The Technical Association of the Pulp and Paper Industry continued in 1952 its steady growth of the past few years. The Annual Meeting and the eight functional conferences were exceptionally well attended.

Membership

There were 734 individual members elected in 1952; 196 resigned or were dropped from the membership. On Dec. 31, 1952, the total individual membership was 5090.

There were 16 corporate members elected in 1952; 8 corporate members resigned. The corporate membership on Dec. 31, 1952, was 234.

There were 18 sustaining members elected in 1952; 4 sustaining members resigned. The sustaining membership on Dec. 31, 1952, was 209.

The following companies became corporate members in 1952:

Adams Fibreboard & Paper Mill Pty. Ltd., S. A., Port Elizabeth, S. A.
Alton Box Board Co., Alton, Ill.
Cartiere de Verona S.p.A., Milan, Italy
Cartonnerie de Kayserberg, Alspach (Haut-Rhin), France
Colthrop Board & Paper Mills Ltd., Thatcham, Berks, England
Columbia Cellulose Co. Ltd., Prince Rupert, B. C., Canada
Courtaulds (Alabama), Inc., Mobile, Ala.
de la Roza Corp., New York, N. Y.
Drimnagh Paper Mills Ltd., Inhicore, Republic of Ireland
ELFA Electrochemical Works Francke Ltd., Aarau, Switzerland
Great Northern Paper Co., Bangor, Me.
Hudson Pulp and Paper Corp., New York, N. Y.
Junckers Savvaerk A/S, Koge, Denmark
Laboratoire Central des Services Chimiques de l'Etat, Paris, France
Papeteries de France, Paris, France
S.A.F.F.A., Milan, Italy

The following companies became sustaining members in 1952:

Albany Felt Co., Albany, N. Y.
Biggs Boiler Works Co., Akron, Ohio
Crosby Chemicals, Inc., DeRidder, La.
Earl Paint Corp., Utica, N. Y.
Fabri-Valve Co. of America, Portland, Ore.
Graton & Knight Co., Worcester, Mass.
Howard Publishing Co., New York, N. Y.
Industrial Nucleonics Corp., Columbus, Ohio
Keratene Co., Inc., Winsted, Conn.
Lauhoff Grain Co., Danville, Ill.
Manchester Machine Co., Middletown, Ohio
Nopco Chemical Co., Harrison, N. J.
Ohio Injector Co., Wadsworth, Ohio
Roots-Connersville Blower Div., Connersville, Ind.
Rotareaed Corp., The, Bronxville, N. Y.
S & S Corrugated Machinery Co., Brooklyn, N. Y.
Trundle Associates, Inc., Cleveland, Ohio
Wolfern Alloy Equipment, E. C., Belleville, N. J.

Necrology

The Association lost the following members through death:

Harry G. Bickley, West Virginia Pulp & Paper Co., Williamsburg, Pa.
William C. Brasfield, Jr., Union Bag & Paper Corp., Savannah, Ga.
Donald J. Campbell, E. I. du Pont de Nemours & Co., Niagara Falls, N. Y.
W. G. Campbell, Forest Products Research Laboratory, Aylesbury, Bucks, England
Thorwald A. Carlson, Forest Products Laboratory, Madison, Wis.
M. E. Cody, Black-Clawson Co., Hamilton, Ohio
John C. Darrah, Penobscot Chemical Fiber Co., Orono, Me.
H. A. DuBois, Kimberly-Clark Co., Neenah, Wis.
P. W. Eason, Lathrop Paper Co., Inc., New York, N. Y.

G. J. Esselin, Esselin Research Div., U. S. Testing Co., Inc., Boston, Mass.
John F. Halladay, Consultant, Elkhart, Ind.
Joseph B. Kindleberger, KVP Co., Kalamazoo, Mich.
Shih-chu Lin, Shihlin Paper Mills, Taipeh, Taiwan, China
Hubert E. Lloyd, The Ruberoid Co., South Bound Brook, N. J.
Gunnar F. Magnuson, A/B Defibrator, Stockholm, Sweden
E. Wesley Munger, The Black-Clawson Co., Hamilton, Ohio
Max Oberdorfer, St. Helens Pulp & Paper Co., St. Helens, Ore.
Onni O. Ojala, *Finnish Paper & Timber Journal*, Helsinki, Finland
H. H. Richmond, Electric Steel Foundry Co., Portland, Ore.
Leo J. Rioux, Fraser Companies Ltd., Edmundston, N. B., Canada
Clarence P. Robinson, Manufacturer's Agent, New York, N. Y.
Russell S. Roeller, Pennsylvania Salt Manufacturing Co., Philadelphia, Pa.
Joseph S. Scheuermann, Bagley & Sewall Co., Watertown, N. Y.
Bourdon W. Scribner, Paper Sect., National Bureau of Standards, Washington, D. C.
Louvian G. Simons, Chas. T. Main, Inc., Boston, Mass.
Surrey W. Slater, Consultant, Lufkin, Tex.
Karl E. Sundqvist, Industria, Inc., New York, N. Y.

Meetings of the Association

In addition to the Annual Meeting eight functional conferences were held. The details of the conferences were published in several issues of *Tappi*.

1952 Annual Meeting

The Annual Meeting was held at the Commodore Hotel on Feb. 18–21, 1952. More than 1800 individuals registered and 107 papers were presented. The annual luncheon was featured by an address by Walter J. Murphy, Editor of *Industrial and Engineering Chemistry*, Washington, D. C., who talked on "Scientific and Technical Manpower Problems." The TAPPI Medal was presented to Raymond S. Hatch of the Hudson Pulp and Paper Co., Palatka, Fla., by Robert B. Wolf on behalf of the Technical Association.

Third Coating Conference

The Coating Committee again sponsored a spring conference. The Third Coating Conference was held at the Sherman Hotel, Chicago, Ill., on May 5–8, 1952. The meeting was featured by a Symposium on "Starch" and the "Evaluation of Printing Quality." John H. Heuer of the Great Northern Paper Co., Millinocket, Me., is Chairman of the Coating Committee. J. G. Bullard of the Corn Products Sales Co., New York, N. Y., and Fred E. Culp of the Consolidated Water Power & Paper Co., Wisconsin Rapids, Wis., were Chairmen of the Symposium. Arrangements for the meeting were taken care of by the TAPPI Chicago Section, V. V. Vallandigham, Kelco Co., Chicago, Ill., Chairman. Peter J. Massey, Consultant, River Forest, Ill., was the luncheon speaker and talked on "New Horizons in Paper Coating. Inspection tours were made through the plants of the Corn Products Refining Co., Argo, Ill., and the American Maize Products Co., Chicago, Ill. There were about 350 individuals registered.

Statistics Conference

The Statistics Committee, John Langmaid, Jr., S. D. Warren Co., Cumberland Mills, Me., Chairman, sponsored a two-week conference on "Statistics" at the University of Maine, Orono, Me., on Aug. 4–16, 1952. In essence the conference was conducted on a lecture and workshop basis. The principal lecturers were Geoffrey Beall, University of Connecticut, Storrs, Conn., C. W. Bicking, Office of the Chief of Ordnance, Washington, D. C., S. H. Kimble, University of Maine, and B. J. Wingersky, Gillette Safety Razor Co., Boston, Mass. There were about 45 individuals registered.

Testing Conference

The Testing Division, James d'A. Clark, Consultant, Longview, Wash., Chairman, conducted the Third Testing Conference of committee meetings at Marshall Hall, College of Forestry, State University of New York, Syracuse, N. Y., on Sept. 10–12, 1952. The entire conference was devoted to the consideration of new and revised testing procedures by the committees of the Testing Division. Participants in the conference were: the Paper Testing Committee, D. H. Newcomb, Riegel Paper Corp., New York, N. Y., Chairman; Nonfibrous Materials Testing Committee, J. P. Casey, A. E. Staley Mfg. Co., Decatur, Ill., Chairman; Chemical Methods Committee, A. S. O'Brien, Eastman Kodak Co., Rochester, N. Y., Chairman; Packaging Materials Testing Committee, L. E. Simerl, Marathon Corp., Rothschild, Wis., Chairman; Microscopy Committee, C. E. Brandon, Howard Paper Mills, Dayton, Ohio, Chairman; Pulp Testing Committee, R. I. Thieme, Soundview Pulp Div., Scott Paper Co., Everett, Wash., Chairman; and the Wax Testing Committee, A. M. Heald, Scott Paper Co., Chester, Pa., Chairman. About 115 individuals were present.

Engineering Conference

The Seventh Engineering Conference was held at the Morrison Hotel, Chicago, Ill., on Oct. 13–16, 1952. C. J. Sibler of the West Virginia Pulp and Paper Co., New York, N. Y., was General Chairman. The total registration was 470 individuals. W. R. McNally of the Link Belt Co., Chicago, was Chairman of the Local Arrangements Committee.

The technical program was sponsored by the committees of the division: Mill Maintenance and Materials Committee, H. F. Parker, New York and Pennsylvania Co., Lock Haven, Pa., Chairman; Materials Handling Committee, A. P. Schnyder, Ebasco Services, Inc., New York, N. Y., Chairman; Drying and Ventilating Committee, M. L. Barker, Beckett Paper Co., Hamilton, Ohio, Chairman; Steam and Power Committee, H. R. Arnold, Riegel-Carolina Corp., Acme, N. C., Chairman; Mill Design and Economic Aspects Committee, P. A. Forni, Mutual Security Agency, Washington, D. C., Acting Chairman; Chemical Engineering Committee, J. R. Lientz, Union Bag & Paper Corp., Savannah, Ga., Chairman; Electrical Engineering Committee, R. W. Foster, Champion Paper & Fibre Co., Canton, N. C., Chairman; Hydraulics Committee, K. J. Mackenzie, Eastman Kodak Co., Rochester, N. Y.; and Engineering Research and Machine Committee, J. D. Lyall, Armstrong Cork Co., Lancaster, Pa., Chairman. A. J. Miller, Jr., Assistant Director of Industrial Relations, Mead Corp., Chillicothe, Ohio, was the luncheon speaker. His topic was "People Have a Place in Your Planning." Following the conference, inspection tours were made through the Stock Yards and the plants of the Crane Co. and the Inland Steel Co.

Fibrous Agricultural Residues Conference

The Ninth Fibrous Agricultural Residues Conference was held at the Northern Regional Research Laboratory, Peoria, Ill., on Oct. 27–28, 1952. S. I. Aronovsky of the Laboratory was Chairman. The program of October 27 featured a discussion of "Straw and Hay Standards," and a round-table discussion of "Straw Specifications and Grading." At the dinner at the Hotel Pere Marquette, C. O. Smith, Industrial Engineer of Hiram Walker & Sons, Inc., Peoria, Ill., talked on "What We Expect of Corrugated Shipping Containers." The program of October 28 was devoted to subcommittee meetings and an inspection tour of the Northern Regional Research Laboratory. Seventy individuals were present, including a group from the Netherlands.

Plastics Conference

The Eighth Plastics Conference was held in the Baker Auditorium, College of Forestry, State University of New York, Syracuse, N. Y., on Nov. 5–6, 1952. E. C. Jahn of the College of Forestry was Chairman. The program featured

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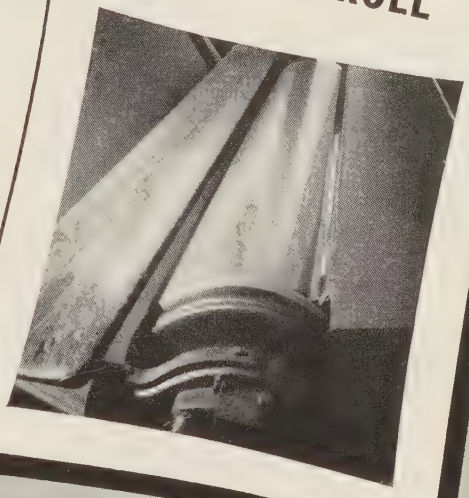

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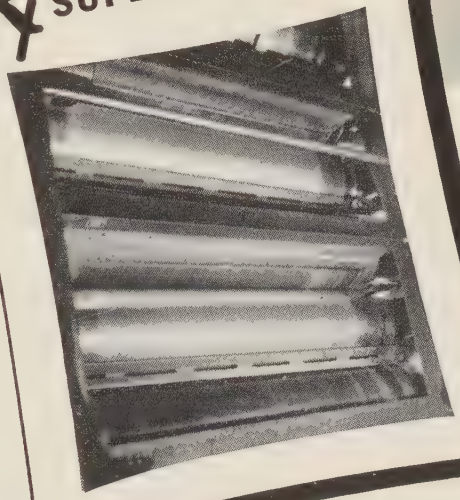

sessions on "Fundamental Resin Problems," R. Lindenfelser, American Cyanamid Co., Stamford, Conn., Chairman; "Special Resin Systems and Technical Problems," A. J. Barry, Dow Chemical Co., Midland, Mich., Chairman, and "Plastic Applications to Paper," R. T. Nazzaro, Westfield River Paper Co., Russell, Mass., Chairman. A plant inspection tour was made through the new coating laboratory of the Dilts Machine Co. at Fulton, N. Y. Two hundred and twelve individuals were registered.

Alkaline Pulping Conference

The Sixth Alkaline Pulping Conference was held at the Battle House, Mobile, Ala., on Nov. 12–14, 1952. R. R. Fuller of the Gulf States Paper Co., Tuscaloosa, Ala., was Chairman of the Alkaline Pulping Committee that sponsored the conference. A. W. Pesch of the Southern Kraft Div., International Paper Co., Mobile, and Robert B. Reynolds, of the Hollingsworth & Whitney Co., Mobile, were Co-chairmen of the conference.

The conference featured the following symposia: "Sulphur and Soda Recovery," R. B. Reynolds, Moderator; "General Recovery Room Operation," John J. Goss, Gaylord Container Corp., Bogalusa, La., Moderator; and "Reduction of Kraft Mill Odors," R. R. Fuller, Moderator. Inspection tours were made through the mills of the Southern Kraft Div., International Paper Co., and the Hollingsworth & Whitney Co., in Mobile.

The luncheon program featured an address by Judge Ben D. Turner of Mobile. Erling Ries, Vice-President of the Southern Kraft Div., was toastmaster. About 400 individuals were registered.

Corrugated Containers Conference

The Second Corrugated Container Conference was held at the Schroeder Hotel, Milwaukee, Wis., on Nov. 20–21, 1952. Burt Mendlin of Cornell Paperboard Products Co., Milwaukee, was General Chairman. The conference was sponsored jointly by the Chicago Section, and the Corrugated Containers Committee, F. D. Long, Container Corp. of America, Chicago, Ill., Chairman. W. R. Tobin of the American Boxboard Co., Grand Rapids, Mich., was Moderator of the technical sessions which featured discussions of "Combining," "Warping and Washboarding," "High-Low Corrugations," and "Corrugator Delivery Tables." The second day of the conference featured inspection tours of the plants of Cornell Paperboard Products Co., Downing Box Co., and the Gaylord Container Co. Two hundred and thirteen individuals were registered.

Publications of the Association

Tappi

Tappi, the monthly technical magazine of the Association, completed its fourth successful year in December, 1952. In June, 1952, at the annual meeting of the National Industrial Advertisers Association in Chicago, the publication received the 1952 Award of Merit for outstanding graphic presentation published during 1951 in the Fourteenth Annual Editorial Competition for Class, Institutional, and Professional Papers. This competition was sponsored by the national publication *Industrial Marketing*. More than 600 publications were entered in the competition. This was the second consecutive year that *Tappi* has achieved distinction in this competition.

Bibliography of Paper Making

The Bibliography of Paper Making and U. S. Patents for 1951 was issued as an annual publication. In addition to the 1951 patents this volume included the patents issued in 1950 since the 1946–50 collective Bibliography did not include 1950 patents. The Bibliography was compiled by C. J. West of The Institute of Paper Chemistry and Chairman of the TAPPI Bibliography Committee. The annual bibliographies cover all articles of a technical nature concerning pulp and paper published since 1900. The pulp and paper industry is the only industry that has such a complete record of its technical literature since 1900.

TAPPI Standards

During 1952 one new suggested method (T 481 sm-52 Fiber Orientation in Paper (Zero-Span Tensile Strength)) and one new tentative standard method (T 482 m-52 Water Vapor Permeability of Sheet Materials at 0°F.) were approved and published. Several methods were revised and changed in status. The Report of the Standards Committee is published in the March, 1953, issue of *Tappi*.

Monographs

A monograph, No. 9 on "Protein and Synthetic Resins for Paper Coating," was published and issued in 1952. This monograph was sponsored by the TAPPI Coating Committee and was prepared under the direction of Miss R. M. K. Cobb of the Lowe Paper Co.

TAPPI Medal Award

The 1952 TAPPI Medal Award was presented to Raymond S. Hatch of the Hudson Pulp & Paper Co., Palatka, Fla.

TAPPI Fibrary

The TAPPI Fibrary, located at The Institute of Paper Chemistry, Appleton, Wis., published a supplementary index of new fibers available, in the September, 1952, issue of *Tappi*.

Employment

The TAPPI Employment Service was very active during the past year. Seventy-three positions open were advertised in *Tappi* and fifty-four individuals applied for new positions. Most of the open positions were filled. The handling of employment matters requires a large amount of correspondence but the Association's Secretary has always felt that the service is very important. A perusal of the section entitled TAPPI Notes in each monthly issue of *Tappi* reflects the large number of changes in employment that takes place in the industry each year. During the past year there was relatively little unemployment in the industry.

Research Projects

During 1952 the research grants made by the Association amounted to $28,451.60. The grants were made to finance research projects sponsored by the Association committees. $60,000 was appropriated by the Executive Committee in February, 1952, to finance such projects during 1952. Details concerning the projects are reported in the Report of the Chairman of the Research Appropriations Committee in the March, 1953, issue of *Tappi*.

Local Sections

The Southeastern Section received its charter on Sept. 19, 1952, at the King and Prince Hotel, Sea Island, Brunswick, Ga.

The chairmen of the local sections elected during 1952 were as follows:

Pacific—Svarre E. Hazelquist, Pulp Div., Weyerhaeuser Timber Co., Longview, Wash.
Lake States—Herbert W. Rowe, Nekoosa-Edwards Paper Co., Port Edwards, Wis.
Delaware Valley—H. C. Brill, E. I. du Pont de Nemours & Co., Newport, Del.
Kalamazoo Valley—A. T. Luey, Sutherland Paper Co., Kalamazoo, Mich.
New England—H. W. Knudson, Hollingsworth & Vose, East Walpole, Mass.
Ohio—C. E. Brandon, Howard Paper Mills, Inc., Dayton, Ohio
Empire State—Robert M. Drummond, International Paper Co., Glens Falls, N. Y.

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Maine-New Hampshire—Joseph J. Thomas, S. D. Warren Co., Cumberland Mills, Me.
Chicago—V. V. Vallandigham, Kelco Co., Chicago, Ill. (now with Potlatch Forests, Inc., Lewiston, Idaho)
Lake Erie—William Schoenberg, Lord & Schoenberg, Cleveland, Ohio
Southeastern—Glenn C. Kimble, Union Bag & Paper Corp., Savannah, Ga.
Papermakers and Associates of Southern California (unaffiliated)—J. T. Cooey, Container Corp. of America, Los Angeles, Calif.

Divisions and Committees

The divisions and committees of the Association were very active in 1952. The steadily growing interest from year to year on the part of the committees can be attributed in part to better committee organization, especially in the establishment of subcommittees having important objectives and projects; to the establishment of more Association sponsored research projects; and to the growing interest in the function regional meetings sponsored by many divisions. Since the various activities of the committees are reported in considerable detail in the monthly issues of *Tappi* the following summary relates largely to information about chairmen personnel and changes made during the year.

Engineering Division: C. J. Siber, West Virginia Pulp & Paper Co., New York, N. Y., General Chairman, and Walter C. Bloomquist, General Electric Co., Schenectady, N. Y., General Secretary. *Steam and Power Committee:* Wilfred Wyburn, Federal Paper Board Co., Inc., Bogota, N. J., succeeded H. R. Arnold, Riegel-Carolina Corp., Acme, N. C., as Chairman. *Materials Handling Committee:* A. P. Schnyder, Ebasco Services, Inc., New York, N. Y., Chairman. *Drying and Ventilating Committee:* Curt A. Young, Riegel Paper Corp., Milford, N. J., succeeded M. L. Barker, Beckett Paper Co., Hamilton, Ohio, as Chairman. *Engineering Research and Machine Design Committee:* John D. Lyall, Armstrong Cork Co., Lancaster, Pa., Chairman. This committee has four subcommittees: *Centralized Control of Stock Systems Subcommittee:* L. A. Moore, American Coating Mills, Elkhart, Ind., Chairman; *Methods for Estimating Costs of Engineering Projects Subcommittee:* H. G. Ingraham, Chas. T. Main, Inc., Boston, Mass., Chairman; *Correlation of Various Types of Plastometers Subcommittee:* K. W. Brenner, Eastman Kodak Co., Rochester, N. Y., Chairman. *Machine Design Data Subcommittee:* G. E. Clink, Sandy Hill Iron & Brass Works, Hudson Falls, N. Y., Chairman. *Mill Design and Economic Aspects Committee:* R. A. Packard, Mutual Securities Administration, Washington, D. C., Chairman. *Hydraulics Committee:* K. J. Mackenzie, Eastman Kodak Co., Rochester, N. Y., Chairman. *Mill Maintenance and Materials Committee:* H. F. Parker, New York & Pennsylvania Co., Lock Haven, Pa., Chairman. *Electrical Engineering Committee:* Ray W. Foster, Champion Paper & Fibre Co., Canton, N. C., Chairman. There are five subcommittees in the Electrical Engineering Committee. *Motor Characteristics Subcommittee:* R. F. Sorenson, Union Bag & Paper Corp., Savannah, Ga., Chairman. *Cable Subcommittee:* A. O. Mortenson, St. Regis Paper Co., Pensacola, Fla., Chairman. *Chipper Drive Subcommittee:* M. J. Osborne, Bowater's Southern Paper Corp., Calhoun, Tenn. *AC-Motor Control Subcommittee:* R. W. Foster, Chairman. *Downtime on Electrical Sectional Drive Subcommittee:* R. F. Sorenson, Chairman. *Chemical Engineering Committee:* J. R. Lientz, Union Bag & Paper Corp., Savannah, Ga., Chairman. *Digester Corrosion Subcommittee:* Nicholas Shoumatoff, West Virginia Pulp & Paper Co., New York, N. Y., Chairman. *Data Sheets Committee:* Henry J. Perry, Waste Paper Utilization Council, New York, N. Y., Chairman.

Research Development Divisions: Walter F. Holzer, Crown Zellerbach Corp., Camas, Wash., General Chairman. *Bibliography Committee:* C. J. West, Institute of Paper Chemistry, Appleton, Wis., Chairman. *Fundamental Research Committee:* Harry F. Lewis, Institute of Paper Chemistry, Appleton, Wis., Chairman. *Statistics Committee:* John F. Langmaid, Jr., S. D. Warren Co., Cumberland Mills, Me., Chairman. *Microbiological Committee:* R. F. DeLong, Marathon Corp., Rothschild, Wis., Chairman. *Testing of Mildew Resistance Subcommittee:* B. F. Shema, Institute of Paper Chemistry, Appleton, Wis., Chairman. *Microbiological Monograph Subcommittee:* J. W. Appling, Buckman Laboratories, Memphis, Tenn., Chairman. *Patents Committee:* Frank Makara, Patent Attorney, New York, N. Y., Chairman.

Industrial Division: R. W. Kumler, American Cyanamid Co., New York, N. Y., Chairman. *Training and Education Committee:* J. H. Groves, Union Bag & Paper Corp., Savannah, Ga., succeeded B. E. Lauer, University of Colorado, Boulder, Colo., as Chairman. *Cost Engineering Committee:* A. E. Bachmann, Mississquoi Corp., Sheldon Springs, Vt., Chairman. *Nonfibrous Raw Materials Committee:* E. N. Poor, Hudson Pulp & Paper Co., Augusta, Me., Chairman. *Mill Instrument Control Committee:* No Chairman. *Water Committee:* A. S. Erspamer, St. Helens Pulp & Paper Co., St. Helens, Ore., Chairman. There are four subcommittees in the Water Committee. *Analytical and Testing Methods Subcommittee:* W. A. Tanzola, W. H. & L. D. Betz, Philadelphia, Pa., Chairman. *Special Projects Subcommittee:* E. N. Poor, Chairman. *Water Supply and Treatment Subcommittee:* Harvey J. Skinner, Boston, Mass. *White Water Utilization and Waste Disposal Subcommittee:* C. C. Porter, Southland Paper Mills, Lufkin, Tex., Chairman. *Fibrous Agricultural Residues Committee:* S. I. Aronovsky, Northern Regional Research Laboratory, Peoria, Ill., Chairman. There are five subcommittees. *Procurement, Storage, and Preservation Subcommittee:* H. M. Blandin, Central Fibre Products Co., Quincy, Ill., Chairman. *Raw Materials Classification Subcommittee:* S. I. Aronovsky, Chairman. *Pulping Subcommittee:* J. R. Little, Hinde & Dauch Paper Co., Sandusky, Ohio, Chairman. *Board and Paper Manufacture Subcommittee:* M. F. Knack, River Raisin Paper Co., Monroe, Mich., Chairman. *Testing Subcommittee:* W. L. Cassiday, Alton Boxboard Co., Alton, Ill., Chairman. *Structural Fibrous Materials Committee:* E. M. Jenkins, Johns-Manville Research Center, Manville, N. J., Chairman. There are ten subcommittees. *New Projects and Review Subcommittee:* J. O. Burton, Minnesota & Ontario Paper Co., International Falls, Minn., Chairman. *Paper, Publication and Review Subcommittee:* J. F. Campbell, Flintkote Co., Meridian, Miss., Chairman. *Test Board Formation Subcommittee:* R. C. Lacey, Celotex Co., Marero, La., Chairman. *Drainage-Time Testing Subcommittee:* J. J. Perot, Flintkote Co., Whippany, N. J., Chairman. *Transverse and Deflection Subcommittee:* J. F. Campbell, Chariman. *Water Absorption, Water Penetration, and Water Vapor Permeability Subcommittee:* A. T. Walton, Simpson Logging Co., Shelton, Wash. Chairman. *Nail Holding and Racking Test Subcommittee:* T. C. Duvall, Wood Conversion Co., Cloquet, Minn., Chairman. *Light Reflection Measurements Subcommittee:* W. L. Scott, Armstrong Cork Co., Lancaster, Pa., Chairman. *Consistency Measurements of Insulating Board Pulp Subcommittee:* A. H. Chamberlain, Bird & Son, Phillipsburg, R. I. *Test Board vs. Hand Sheets for Board Pulp Evaluation Subcommittee:* C. K. Textor, Bauer Bros. Co., Springfield, Ohio, Chairman.

Converting and Consuming Division: L. K. Burnett, Ohio Boxboard Co., Rittman, Ohio, succeeded M. L. Downs, Thilmany Pulp & Paper Co., Kaukauna, Wis., as General Chairman. *Corrugated Containers Committee:* F. D. Long, Container Corp. of America, Chicago, Ill., Chairman. There are nine subcommittees. *Adhesives Subcommittee:* Burt Mendlin, Cornell Paperboard Products Co., Milwaukee, Wis., Chairman. *Taping Subcommittee:* R. A. Purdy, International Paper Co., Somerville, Mass., Chairman. *Stitching Subcommittee:* W. W. Marteny, National Container Corp., Tomahawk, Wis., Chairman. *Waste Sub-*

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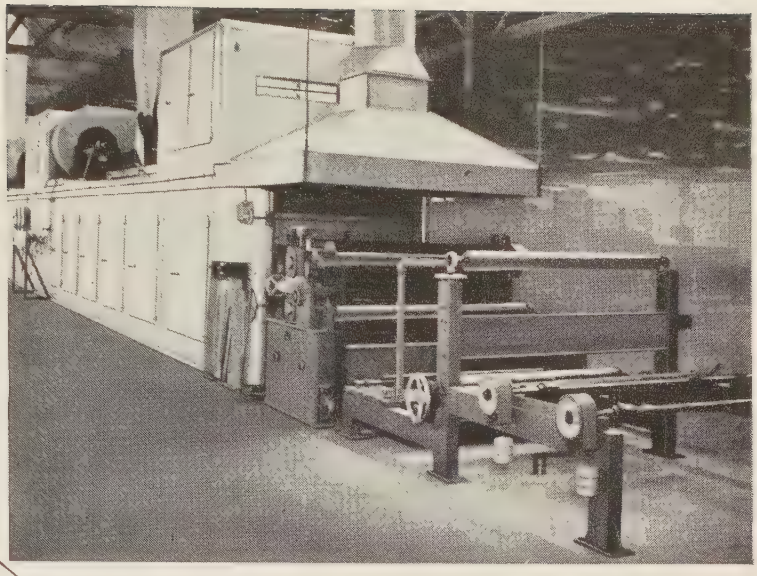

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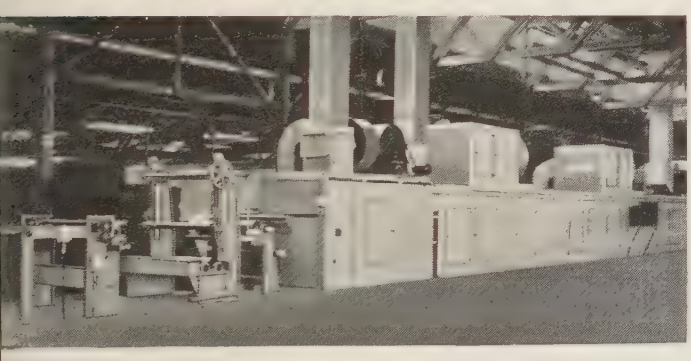

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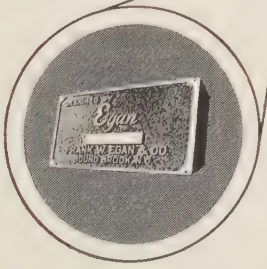

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Pulp Manufacture Division: K. O. Elderkin, Bowater's Southern Paper Co., Calhoun, Tenn., General Chairman. *Acid Pulping Committee:* E. H. Woodruff, Rayonier, Inc., Port Angeles, Wash., Chairman. *Alkaline Pulping Committee:* R. R. Fuller, Gulf States Paper Co., Tuscaloosa, Ala., Chairman. *Semichemical Pulping Committee* (New): J. N. McGovern, Forest Products Laboratory, Madison, Wis., Chairman. There are four subcommitees: *Equipment Survey Subcommittee:* J. E. Sapp, Gaylord Container Corp., Bogalusa, La., Chairman. *Semichemical Pulping Measures Subcommittee:* R. Brown, Oxford Paper Co., Rumford, Me., Chairman. *Standard Terms Subcommittee:* C. K. Textor, Bauer Bros. Co., Springfield, Ohio. *Bibliography and Review Subcommittee:* J. N. McGovern, Chairman. *Mechanical Pulping Committee:* F. W. O'Neil, College of Forestry, State University of New York, Syracuse, N. Y., Chairman. *Chemical Products Committee:* Arthur Pollak, Consultant, New York, N. Y., Chairman. *Paper Deinking Committee:* J. J. Forsythe, International Paper Co., Niagara Falls, N. Y., Chairman. *Pulp Purification Committee:* R. L. McEwen, Buffalo Electro-Chemical Co., Buffalo, N. Y., Chairman.

Paper Manufacture Division: R. P. Price, Hammermill Paper Co., Erie, Pa., General Chairman. *Preparation of Papermaking Materials Committee:* F. S. Klein, Byron Weston Co., Dalton, Mass., Chairman. *Fillers Monograph Subcommittee:* R. J. Proctor, West Jersey Paper Co., Camden, N. J.; *Significance of Sizing Tests Subcommittee:* R. G. Mispley, Crown Zellerbach Corp., Camas, Wash., Chairman. *Paper Making (Cylinder) Committee:* J. J. Harrison, Michigan Carton Co., Battle Creek, Mich., Chairman. *Paper Making (Fourdrinier) Committee:* N. R. Phillips. Champion Paper & Fibre Co., Canton, N. C., Chairman. *Tissue Subcommittee:* L. P. Thompson, Personal Products Co., Milltown, N. J.

Testing Division: James d'A. Clark, Consultant, Longview, Wash., General Chairman. *Fibrous Materials Testing Committee:* E. R. Schafer, Forest Products Laboratory, Madison, Wis., Chairman. *Nonfibrous Materials Testing Committee:* James P. Casey, A. E. Staley Mfg. Co., Decatur, Ill., Chairman. There are eight subcommittees. *Testing of Enzymes Subcommittee:* Alexander Frieden, Pabst Laboratories, Milwaukee, Wis.; *Testing of Rosin Size Subcommittee:* D. D. Cameron, Hercules Powder Co., Wilmington, Del.; *Testing of Clays Subcommittee:* C. G. Albert, Edgar Bros. Co., McIntyre, Ga.; *Testing of Casein Subcommittee:* D. B. Laird, The Borden Co., Bainbridge, N. Y.; *Testing of Coating Starches:* C. C. Kesler, Penick & Ford, Ltd., Inc., Cedar Rapids, Iowa; *Testing of Titanium Dioxide Subcommittee:* W. R. Willets, Titanium Pigment Co., New York, N. Y.; *Testing of Calcium Sulphate Subcommittee:* John Lewis, University of Maine, Orono, Me.; and *Testing of Animal Glue Subcommittee:* Chairman to be appointed. *Wax Testing Committee:* A. M. Heald, Scott Paper Co., Chester, Pa., Chairman. *Pulp Testing Committee:* R. I. Thieme, Soundview Pulp Div., Scott Paper Co., Everett, Wash. *Optical Properties Committee:* H. E. Obermanns, Hammermill Paper Co., Erie, Pa. *Microscopy Committee:* C. E. Brandon, Howard Paper Mills, Inc., Dayton, Ohio. *Paper Testing Committee:* D. H. Newcomb, Riegel Paper Corp., New York, N. Y.; *Erasing Properties Subcommittee:* P. W. Codwise, Beaver Wood Products Co., Thorold, Ont.; *Container Testing Committee:* C. H. Krebs, Atlas Boxmakers, Inc., Chicago, Ill.; *Packaging Materials Testing Committee:* L. E. Simerl, Marathon Corp., Menasha, Wis. There are four subcommittees. *Water Vapor Permeability Subcommittee:* Charles Southwick, H. P. Smith Paper Co., Chicago, Ill.; *W. V. P. of Completed Packages Subcommittee:* C. M. Woodcock, General Foods Corp., Hoboken, N. J.; *Insect Resistance of Packages, Paper and Paperboard Subcommittee:* H. S. Gardner, Fibreboard Products, Inc., Antioch, Calif.; *Flavor and Odor Transfer Subcommittee:* A. H. Landrock, Dept. of Food Technology, Massachusetts Institute of Technology, Cambridge, Mass. *Chemical Methods Committee:* A. S. O'Brien, Eastman Kodak Co., Rochester, N. Y.; *Alpha, Beta and Gamma-Cellulose Subcommittee:* A. S. O'Brien, Chairman; *Disperse Viscosity Subcommittee:* A. F. Martin, Virginia Cellulose Div., Hercules Powder Co., Wilmington, Del.; *Reducible Sulphur in Paper and Pulp Subcommittee:* C. P. Donofrio, Nekoosa-Edwards Paper Co., Port Edwards, Wis.; *Moisture in Cellulose Subcommittee:* Geoffrey Broughton, University of Rochester, Rochester, N. Y.

Special Committees: *Standards Committee:* Roger C. Griffin, Needham, Mass. *Research Appropriations Committee:* John L. Parsons, Hollingsworth & Whitney Co., Waterville, Me. *Joint Textbook Committee:* Harry S. Spencer, Howard Smith Paper Mills, Beauharnois, Que., Canada. The other members of this committee responsible for the publication of "Pulp and Paper Manufacture" are: R. S. Hatch, Hudson Pulp & Paper Co., Palatka, Fla., Douglas Jones, Technical

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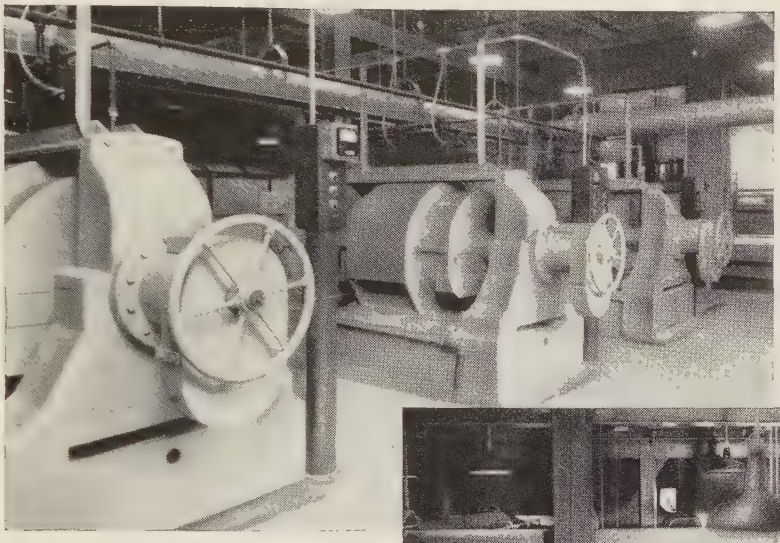

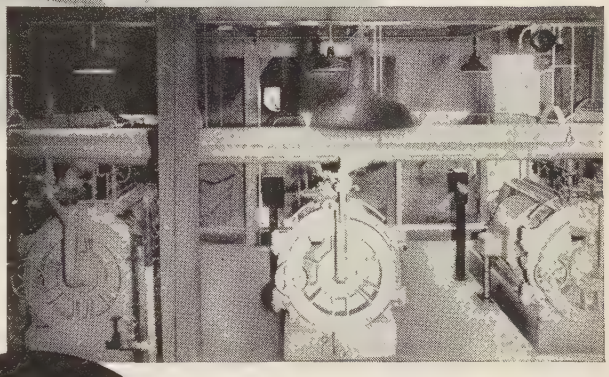

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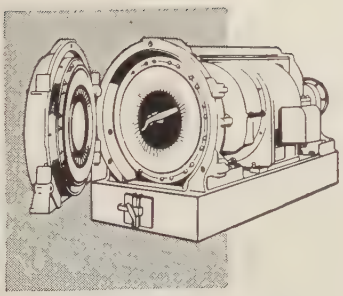

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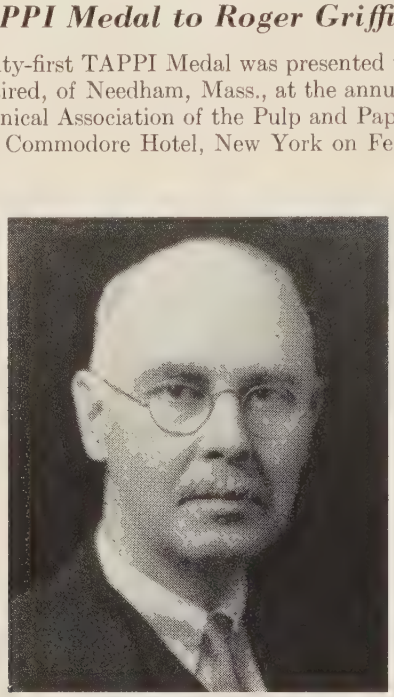
267

Section, Canadian Pulp & Paper Association, Montreal, P. Q., R. G. Macdonald, TAPPI, New York, N. Y., and R. S. Kellogg, Bradenton, Fla. J. N. Stephenson, *Pulp & Paper Magazine of Canada*, Gardenvale, P. Q., is Editor.

R. G. Macdonald, *Secretary* TAPPI

1953 TAPPI Medal to Roger Griffin

The twenty-first TAPPI Medal was presented to Roger C. Griffin, Retired, of Needham, Mass., at the annual luncheon of the Technical Association of the Pulp and Paper Industry held at the Commodore Hotel, New York on Feb. 19, 1953.



Roger C. Griffen

James d'A. Clark, Consulting Engineer of Longview, Wash., and General Chairman of the TAPPI Testing Div. made the presentation on behalf of the Executive Committee of the Association. The remarks of Mr. Clark and Mr. Griffin follow:

Presentation Remarks by James d'A. Clark

It is indeed a rare privilege once more to be permitted the honor of representing the membership of this Association in making a presentation of its distinguished service award, the TAPPI Medal. Because of the absence of the recipient, whose medical adviser has forbidden him to join us today upon this happy occasion, the presentation will be made *per filium* to Roger Castle Griffin, Jr.

Roger Castle Griffin, Sr., was born in Montclair, N. J., nearly three score and ten years ago. He graduated from Harvard, *magna cum laude* in his twenty-first year and then took successively his Master's degrees, first in Arts and then in Science. Following in his father's footsteps, he has had a distinguished chemical career in Cambridge, Mass., latterly as Vice-President of Arthur D. Little, Inc., a company which his father had founded as a partnership with Dr. Little.

Roger joined TAPPI when it started in 1915 and served as Chairman of several committees. In 1936 he was Chairman of the New England Section, and in that year became a member of the TAPPI Executive Committee. Since its inception 20 years ago, Roger has been Chairman of the important Standards Committee.

I knew Roger first through his well-known book "Technical Methods of Analyses" which with its wealth of specifications and data, proved a helpful friend to me as a young man trained only as an engineer, when I became the "Chemist" in a paper mill. Roger was among the first in our industry to recognize the importance of good testing procedures. He heartily concurs in our expressed belief that "it is almost certain that the manufacturer who makes the best tests for the properties of his product, will be the first to improve it."

Few have any idea of the amount of work, thought, and guidance that Roger has contributed toward the formulation of the present TAPPI Standards. I discovered that last year he spent nearly 500 hours on them and that Mrs. Griffin had added another 100 hours or more of her time in helping him.

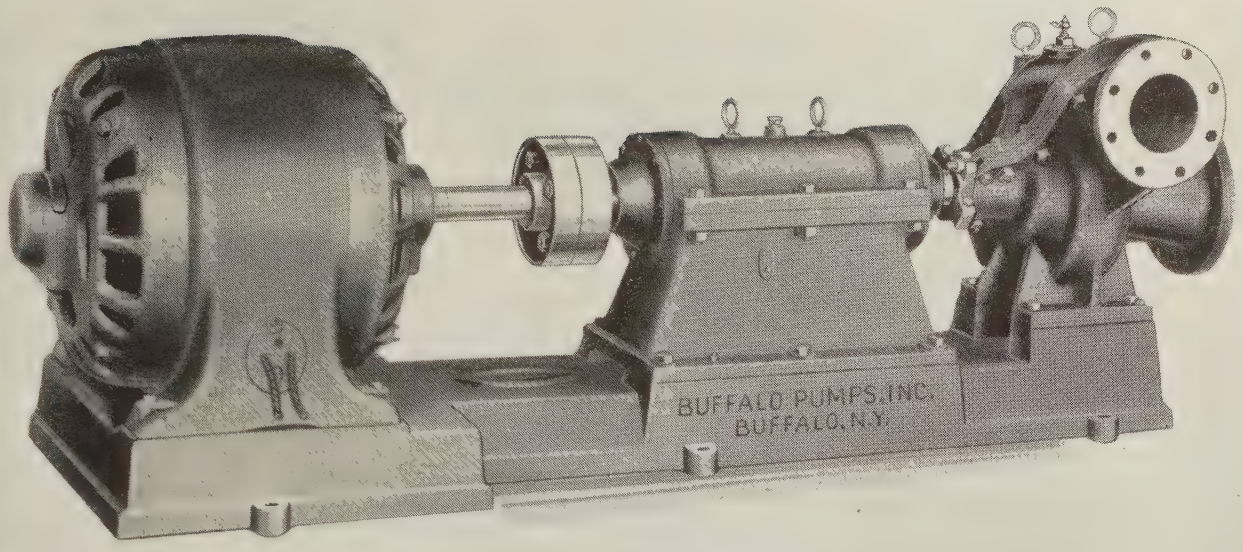
Testing methods are quite often compromises, yet a compromise for a standard method is rarely possible because for specifications or for referee purposes the stipulated test must be carried out precisely in accordance with some one individual method. A choice of alternative procedures, some of which might be just as good as the method selected, is not permissible for such purposes. Thus we have a fertile field, not only for animated discussions, but occasionally also for hurt feelings. That there have been almost no badly hurt feelings in this work in TAPPI over the years, has been very largely due to the understanding, tact, firmness, and above all the fairness and good humor of Roger Griffin.

Many a time when the protagonists of two different procedures for the same testing method became hot and heavy, Roger would carefully consider the matter and write his opinion in a gentle letter with quiet humorous touches to each warrior with copy, as usual, to Ronald Macdonald. As far as I know, no loser (in whose shoes I have often been) ever questioned Roger's understanding of the points at issue nor the soundness of his judgment. Both victor and vanquished lived happily thereafter to fight again another day—but then about some other procedure.

As a case in point, let me give a brief résumé of the second "Battle of the Burst"—Mullen, that is, the first battle having occurred in 1936, when, to secure greater reliability of the bursting test I had advocated the adoption of the Schopper-Dalen tester as the TAPPI reference standard. Don Scribner, to whom I had the honor of presenting the TAPPI Medal ten years later and whose death a year ago was such a shock to his many friends, defeated me after reams of correspondence and several published articles, one of which was by Roger in which he provided additional data and impartially reviewed the issues.

In 1940, fanned by a series of border incidents at the U. S. Customs over the true bursting strength of newsprint, as well as local trade disputes about the test, war broke out anew over my suggestion this time, of adopting a modified hand-driven Mullen tester as the reference standard in order to avoid the uncertain dynamic effect of the rapid pressure rise on the gage readings. In Washington, at the Bureau of Standards, Don Scribner took a firmly entrenched position holding that (a) the bursting test as commonly practiced, was so inherently poor in precision that the existing TAPPI method could not usefully be improved, and (b) if people wanted a more precise test for their purposes, they should use the tensile tests. I countered that (a) the bursting test was a useful one and widely used, (b) people wanted a reproducible bursting test, and (c) it was up to TAPPI to produce one.

Months and several dozens of letters later, Don finally wrote to Mac, with a copy to self and Roger, that we should publish an amendment to the effect that the orifice of the tester should be specified at 1.20 instead of 1.24 inches. I protested, saying that the suggested change was of little consequence; what was needed was a comprehensive revision, but, if we did publish this amendment, so as to provide a little joy to living in those somber times, and in order to try to get the user's mind off the uncertainties of the test, we should also specify that "the frame of the instrument shall be painted grass green in color and pink spots added thereto at intervals of not over one, nor less than one-half inch." You will see that few punches were being withheld. That battle ended in a draw with the following classic letter from Roger to all concerned:



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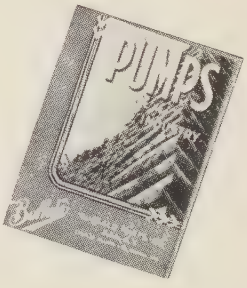
Better write today for BULLETIN 953 and see the full line of "Buffalo" Pumps for the Paper Industry ready to give you years and years of dependable service!



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"With regard to the bursting test, I must confess that I am becoming more and more confused regarding the real points at issue. Two or three years ago someone sent me the following definition: "Mullen Test," "Poptest," "Burst," sometimes called bursting strength.

"These terms are used in referring to a kind of ability to resist stretching, which is determined by means of a test known usually by the name 'Mullen.' When a sheet of paper ruptures either by virtue of extreme stress or extreme strain or both (it is not known which) it 'pops' and is said to have 'burst' whence the other names arise. It is expressed in pounds per square inch, which figure has no connection with any type of unit strength at rupture or deformation at rupture dealt with in the engineering or physical sciences. However, it is of great value to paper producers and users as conclusive evidence of the quality of all kinds of paper being commonly used, and to show the merits of such widely different papers as newsprint, coatings, glassine, and butcher's manila and such as paper boards as corrugated, match board, patent coated, etc. It should always be included in all specifications since without knowing the 'pop,' no business can be consummated."

He then continued: "You may have heard, when you were a boy, the poem beginning, 'Oh, Mullen, whisper in my ear and tell me how you grow.' It seems to me that the paper industry might parody the verse as follows:

'Oh, Mullen, whisper in my ear and tell he what you show.
You must have *some* significance, if we could only know.
You 'burst' with joy on every hand,
But why, we cannot understand.' "

With Roger again as umpire, the third, and it is hoped the final "Battle of the Burst" has just been concluded with the latest TAPPI revision T 404 m-52, based largely upon the excellent work done on the test by Stanley Mason and his associates at the Pulp and Paper Research Institute in Montreal. We believe that we now have a precise and reproducible test.

Roger Griffin married Marian Neilson in 1917 and has three children and five grandchildren. His daughter Betty, a graduate of Colby Junior College, is married to Capt. W. H. Russell, Jr., U.S.A.F., who, after serving in the last war and in Japan and Korea, is now stationed in Washington, D. C. Both sons have chosen technical careers: son Donald who graduated in chemistry from Wesleyan University, is now with the Mathieson Chemical Co., in Niagara Falls, N. Y., after spending two years as an officer in the Navy and about five years at the Jet Propulsion Laboratory of the California Institute of Technology; and son Roger, Jr., who, after attending Harvard, received his Master's degree in Textile Chemistry following a five-year course at Lowell Textile Institute, and now is in the Lastex Dept. of The United States Rubber Co., at Providence, R. I.

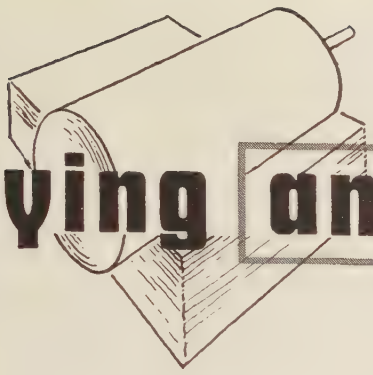
The Luncheon at the 38th Annual Meeting of the Technical Association of the Pulp and Paper Industry, New York, N. Y., Feb. 19, 1953

In his younger days, Roger Senior did quite a bit of traveling, including a few months spent in Cape Town, S. A., and tours through England and Scotland. (I am sorry that I didn't meet him then, but I was only six years old at the time.) Since then, as he modestly puts it, he has "just plodded chemically and TAPPI-ly along." It is not often that such "plodding" has been of such great value and service to so many people, not only here but all over the world.

It is therefore with the greatest of pride that, on behalf of the members of the Technical Association of the Pulp and Paper Industry, I hand this medal to you, Roger Castle Griffin, Jr., to present to your father with our very best wishes and thanks to both him and your mother.

Response by Mr. Griffin

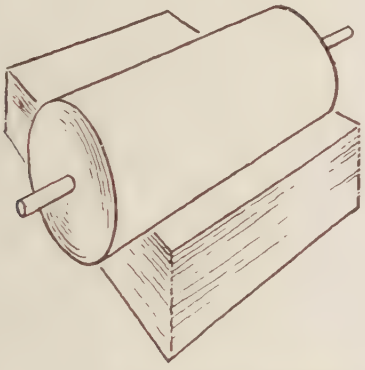
It is with sincere thanks and appreciation that I accept this twenty-first TAPPI Medal. It is also an added pleasure to have it presented by Jim Clark, with whom I have had many a good verbal battle—each one always terminating



buying ammonia

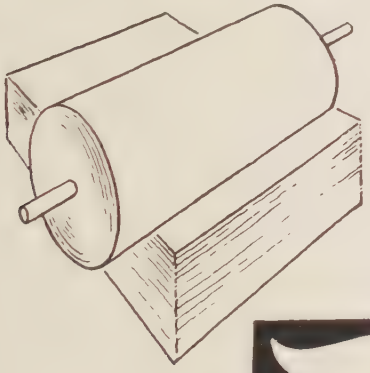
Waste disposal was a problem with a large pulp and paper manufacturing company. They changed to ammonium bisulphite cooking where they could recover much of the chemical value in the waste liquor . . . they found, in addition, the efficiency of the pulping operation was improved and the pulp was of better quality.

to better advantage



Mathieson was the logical choice to supply ammonia. Three major plants, Lake Charles, Niagara Falls and Morgantown, assured a firm source of supply. And, of added advantage, Mathieson also produced caustic soda, soda ash, chlorine, sulphur and sulphuric acid, hypochlorite products, sodium nitrate, sodium chlorite, ammonium sulphate and ammoniacal liquor . . . other important raw materials for pulp and paper production.

from Mathieson



These same advantages will be of benefit to you. You'll be sure of top-quality chemicals . . . multi-plant production facilities provide dependability . . . integrated delivery system assures on-time schedules. You'll find you can buy chemicals to better advantage—at any time—by consulting Mathieson.

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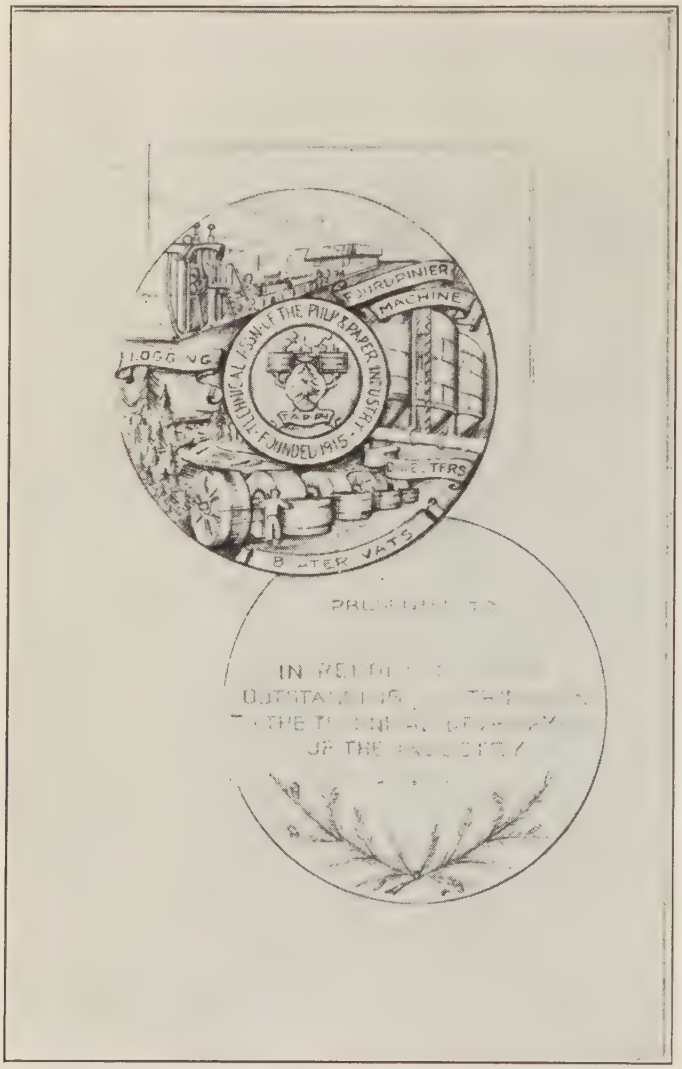
without acrimony in a still deeper and warmer friendship. I consider it a signal honor to be included in this select group to which previously have been chosen such good friends of mine as Ed Sutermeister, Clarence West, Don Scribner, and Bill MacNaughton.

I regret that I cannot be present to greet personally my many TAPPI associates. Unfortunately, it is necessary that my acceptance has to be by remote control from my broadcasting studio in Needham, Mass. For the past few years this has become a miniature Grand Central Station where TAPPI Standards arrive from the various committees and, after a thorough inspection, are either side-tracked for repairs or despatched to the printing station.



The Tappi Medal which was presented to Roger C. Griffin

My father, Roger B. Griffin, graduated from the University of Vermont in the late 1870's and was one of the early members of the American Chemical Society. He became affiliated with a laboratory in Providence, R. I., where he became interested in pulp and paper technology and was, I believe, superintendent of the first sulphite mill. At about this time he became acquainted with another chemist who was interested in pulp and paper, Arthur D. Little, and in 1886 they formed a partnership and organized the laboratories of Griffin & Little at 71 Milk St., Boston. My father was an expert glass blower and there were memorable days in my young life when he would take me in to the laboratory and let me watch him blow glass, make liquids change color, cause minor explosions, let yellow phosphorus burn, and perform other acts of chemical magic. I think that then and there I decided to become a chemist.

My father was killed by an ether explosion in the laboratory in 1893, when I was 9 years old. At that time he and Dr. Little had nearly completed the manuscript for their book "The Chemistry of Paper-Making," which was published about a year later and was the first book on that subject. It is interesting to note that in those days the wire side of machine-made paper was called the right side and the felt side was termed the wrong side. Presumably, therefore, half of the newspapers were printed on the wrong side. Dr. Little carried on the business under his own name for a number of years, except for a brief partnership with Prof. William Walker of M.I.T. I joined his staff at the beginning of 1909 and later in that year the business was incorporated. At that time most of the work consisted of chemical analyses and physical testing, largely for paper concerns and electric street railway companies. It steadily expanded, however, into other fields of testing. The volume of research and engineering work also increased steadily until the analytical and testing section of the business was finally discontinued at the end of 1938.

After 2 years with the Arthur D. Little organization I was made head of the analytical department and continued nominally in charge of it for 27 years although I did not do any actual laboratory work after we moved to Cambridge in 1918. In the course of my work I visited many plants, especially pulp and paper mills, from Nova Scotia to Florida and from Maine to Wisconsin. I started out as an analytical chemist at a time when they were considered important in the technical world. Later they were considered about the lowest form of human chemical specimens. I think, however, the pendulum is swinging back again, and I am proud to consider myself as still basically an analytical chemist, with strong leanings toward paper technology.

In my early days I did quite a bit of referee wood pulp testing and trouble shooting. I remember stepping off the train in Oldtown, Me., one morning with the thermometer 20 degrees below zero. As there was no transportation in sight, I had to walk half a mile or more to the pulp mill, shifting my bag every few yards so I could cover up my other ear. In the machine room the steam was so thick that visibility was practically zero and I had to be led about by the hand to avoid annihilation. A large crack under the door let in the sub-zero air and before opening the door the frozen steam had to be shovelled away.

I shall never forget my first trip to a town in Nova Scotia. Let's call the mill there the Smith Pulp Co. From the tone of previous letters, it was evident that Mr. Smith was a hard man to satisfy. In his last letter he had written that he had another lot of pulp to be tested, "but don't send the fellow you sent before." So I left, feeling like the lamb going to slaughter. When I arrived I found a beautiful little hotel—owned by Mr. Smith. Later I visited the pulp mill and a large lumber mill, both owned by Mr. Smith. The only store in the town was owned by Mr. Smith and Mr. Smith was the head of the local bank. In fact, Mr. Smith owned or controlled practically everything in the town.

The next day I went down to the dock where several thousand bales of pulp were piled. It was connected to the land by a narrow runway. I was given a crew of men and we set to work. There was a gale blowing and it was bitter cold, though not freezing. We made a fortress to protect us from the cold and wind by repiling some of the bales and we worked in that fortress for three days. As the dock was on an arm of the Bay of Fundy, there were tremendous tides and one day the connecting runway was under water and we were marooned in our pulp fortress for several hours.

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On the third day one of Mr. Smith's sons was driving me to the station when a car coming in the opposite direction flagged us down and a voice barked out; "Turn around, I've got some more pulp I want tested." That was the first time I met Mr. Smith. Apparently he had decided I was not afraid of hard work. As a matter of fact, I stayed there the rest of the week and had lunch each day in his beautiful home. He was an autocratic Scotsman who ruled with an iron fist and expected everyone to jump when he spoke. Yet underneath he was a fine gentleman and a devout churchman. I accepted his invitation to accompany him and his family to a week-day service at the kirk, and that apparently did it! In his next request for a pulp test, he wrote: "Please send young Griffin." I was genuinely grieved to learn later that all of his several sons were killed in World War I.

For diversity of experience I can recommend working in an independent testing and consulting company. When I joined the Arthur D. Little staff in 1909, the company had 35 methods of testing especially written up for its own use. During the following 29 years I prepared 302 additional methods, covering materials from Acetic Anhydride to Zirconia Pigments. In many of these methods were included not only testing procedures but a brief description of the material and general tolerances or specifications. In 1920 it was decided to cull over our methods, which then numbered over 200, and select such as seemed suitable as the basis of a book on testing. This was published in 1921 under the title "Technical Methods of Analysis." Much to my surprise, it attained sufficient success to justify a revised and enlarged second edition, published in 1927 and not dead yet.

One of the pleasant aspects of independent testing work and technical consulting is meeting people; and one of the best opportunities of meeting people is by membership in technical societies. Dr. Little recognized this by urging his associates to join such societies and by paying their dues in some cases. I joined TAPPI in 1915 and the following year was appointed to one of its first technical committees, that on methods of testing, serving on the subcommittee on rosin and rosin sizing. After several years' service on the Paper Testing Committee, I accepted the Chairmanship of the Nonfibrous Materials Testing Committee and in the four years from 1929 to 1932 I wrote up 21 methods which were approved by the committee and became TAPPI standards.

In 1933 I became General Chairman of the Testing Division and continued as such for three or four years. In 1933 also, the present Standards Committee was organized and I was offered the Chairmanship, a position which I have now hung on to for 19 years.

At an ASTM meeting in the middle 30's I was approached by its Secretary to undertake the organization of an ASTM Paper Committee. I told Clark Heritage, who was then President of TAPPI, that I would do so if he would help. After about two years of correspondence and consultation, Committee D-6 on Paper was formally organized at a meeting in New York in June, 1937, and I served three years as its first Chairman.

You can see from the foregoing that for some 43 years I have been directly concerned with methods of analysis and testing, as well as with specifications and with technical committee work. None of my work has been more enjoyable or more satisfying than that devoted to the work of TAPPI committees, especially the Standards Committee, because it has helped to produce tangible, visible results which not only are useful to many people in one of the most important industries, but should continue to expand in usefulness.

When the present Standards Committee was organized in 1933 there were 55 TAPPI Standards. We now have 177 Standards and 16 Suggested Methods. Many of the early standards were issued just as they were originally written, with no attempt at a uniform style. We have gradually adopted a set of Regulations Governing Standards and Suggested Methods which is published in the *TAPPI Year Book* and which should be carefully read by the chairman of every committee concerned with the development of standards. In an attempt to bring our standards into uniform shape and correct minor mistakes, we have issued 239 "corrected" standards since 1932. We have also publishd 9 major revisions.

It should be emphasized that the Standards Committee does not originate any TAPPI Standards. They are developed in the various technical committees, sometimes after years of work on a single standard, and great credit is due to these committees for their splendid work. The Standards Committee acts as a screening and coordinating body. It has the final say, however, on each Tentative Standard or Suggested Method until it is ready to be submitted to letter ballot of the TAPPI membership for advancement to an Official Standard, and in my opinion—which is probably prejudiced—is one of the most important TAPPI committees.

I hope I have not bored you by my TAPPI statistics and rambling reminiscences. I remember two men sitting at the head table of a meeting who were due to make speeches. One said, "Does it bother you when people begin to look at their watches?" The other replied, "No, that does not bother me; it's when they look at their watches and then hold them up to their ears!" Not wishing to cause such a situation I will close by making a couple of suggestions:

The first suggestion has to do with the Standards Committee. The success of any Technical Committee depends largely upon its Chairman. He organizes, plans, and directs the work, but in most cases the actual work is apportioned among the members. The Standards Committee, however, is unique and about $99^{44}/_{100}\%$ of its work falls upon the Chairman. The other members merely study each proposed standard as it is presented and vote by letter ballot to accept, amend or reject. While this voting is of great importance and requires experience, knowledge, and judgment, it occupies comparatively little time of the individual voter.

On the other hand, the Chairman should keep in contact with the chairmen of all the other committees which are concerned with Standards. (At present I have active folders for 21 such committees.) He must see that all proposed standards are in proper form before sending them out for vote. Some of them require extended correspondence and redrafting before this stage is reached. He must keep a record of all new standards, as well as corrections and revisions, and once a year send them to New York for looseleaf printing. This also involves keeping the looseleaf indexes up to date for the annual printing. In short, to do a good job the Standards Committee Chairman must be familiar with chemical and physical testing, editorial work, proofreading, TAPPI rules and regulations, policy matters, and the work of various committees, as well as with TAPPI Standards.

The work requires more time than should be expected to be done voluntarily by any individual in connection with his regular job in a private company. My suggestion is, therefore, that the next Chairman of the Standards Committee should be a properly qualified person hired to be a member of the TAPPI headquarters staff in New York. He might also logically handle other TAPPI publications, such as the Data Sheets, Routine Control Methods, etc. I hope that day will not come too soon, however, as I thoroughly enjoy the work.

My second suggestion is this: If you are a member of TAPPI mainly for what you expect to get in return—and you will get a lot—that, I suppose, is your own affair. But if you want to get the most out of your membership, take part in committee work. I urge, particularly, younger members to join some committee. These committees are the vitalizing force of TAPPI. Their work not only produces the tangible results which are of continuous and lasting benefit to the

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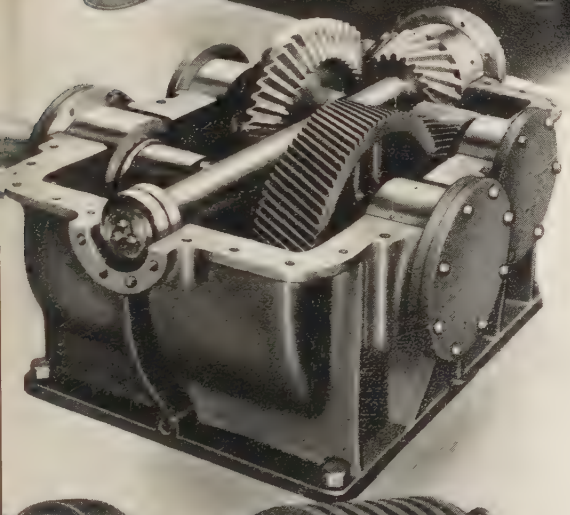

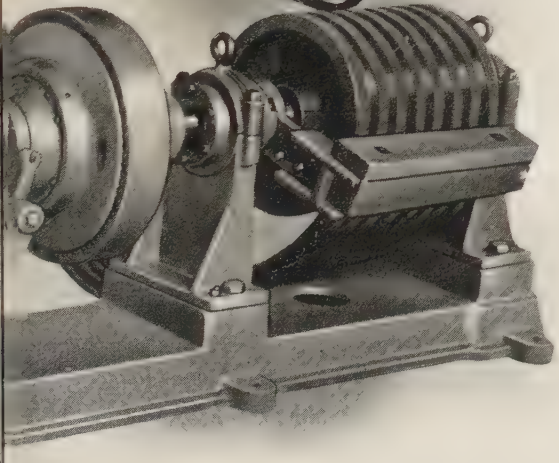

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Sandy Hill does not build a cheap drive because it believes that a drive which will last over a long period of years with no more attention than adequate inspection and lubrication is the most economical per ton of paper made.

Features

Unvarying draw between sections.

Fineness of draw regulation.

Simplicity of design that keeps maintenance within the ability of the good paper mill millwright.

Power saving and low first cost to a degree hitherto unknown.

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many, but it produces intangible results for the committee members, in valuable experience, the pleasure of meeting and teaming up with others, and the deep satisfaction of accomplishment. I ought to know; I have had over 30 years of it!

And now this is Old Man Standards signing off, with kindest regards to my many friends in TAPPI and with many thanks for the signal honor you have seen fit to bestow upon me.

Report of Standards Committee for 1952

One gets the distinct impression that during 1952 there has been a notable upsurge of activity in regard to Standards and Suggested Methods among several of the TAPPI committees. Correspondence has been unusually heavy and a considerable number of "rough drafts" have been submitted for comment and suggestions. This is an excellent idea and they are always welcome, but these rough drafts should at least be smoothed down to the extent that they are in the approved TAPPI format. A little more care in this respect would save considerable unnecessary work and correspondence. This, of course, is even more important in the case of Standards submitted for official action of the Standards Committee. Several of the proposed Standards submitted had to be returned for extensive rewriting.

New and Revised Standards

During 1952 one new Tentative Standard and one new Suggested Method were approved and published:

T 481 sm-52. Fiber Orientation in Paper (Zero-Span Tensile Strength) (*1*)
T 482 m-52. Water Vapor Permeability of Sheet Materials at 0°F. (*2*)

A revision of Tentative Standard O 406 p-50, Standard Terms Used in the Sulphite Pulping Process, was approved and published (*3*) and it was voted that it be submitted by letter ballot to the membership for advancement to Official under a new number, O 300 p, together with the following Tentative Standards:

T 7 p-49. Weight-Volume Measurements of Pulpwoods and Chips
T 18 m-50. Specific Gravity and Moisture Content of Pulpwood
T 620 m-52. Analysis of Industrial Process Water (as corrected in 1952)
T 634 m-47. Melting Point of Petrolatum

Revisions of two Official Standards were approved and published:

T 403 m-47. Bursting Strength of Paper (*4*)
T 412 m-42. Moisture in Paper and Paperboard (*5*)

It was voted that T 403 m be reverted to a Tentative Standard. The other revision will be submitted by letter ballot to the TAPPI membership for approval.

Revisions of two Suggested Methods were approved and published:

T 226 sm-52. Specific External Surface of Pulp (*6*)
T 478 sm-52. Ink-Erasing Quality of Paper (*7*)

The following Tentative Standard was approved for advancement to Official but it was voted that it first be published (*8*) in corrected form and the title changed to Acid-Insoluble Lignin in Wood Pulp, namely:

T 222 m-50. Lignin in Wood Pulp

In addition, a method for Viscosity of Starch and Starch Products has been accepted under the number T 637 m. It is awaiting publication pending the acceptance of a companion method for Analysis of Starch and Starch Products submitted to the committee in December, together with a proposed revision of T 628 m-43, Analysis of Rosin Size.

During the year, the committee voted on a total of 16 submissions, including advancements, rejecting one and postponing one.

Contents of Book of Standards

In August the manuscript for the annual printing of loose leaf Standards for 1952 was sent to the New York Office. The final proof was corrected and returned in the middle of October but again there has been a delay in completing the mailing. When it is sent out it will consist of the following:

2 new Suggested Methods
2 revised Suggested Methods
2 revised Tentative Standards
2 revised Official Standards
1 Tentative Standard advanced to Officia
8 corrected Standards

When these are included, the manual will consist of the following:

	Tentative	*Official*	*Total*
Standard recommended practices	2	11	13
Standard specifications	4	1	5
Standard testing methods	44	114	158
Suggested methods	. .	. . .	17
	50	126	193

Jurisdiction of Committees

The new methods published in 1952 are under the jurisdiction of the following committees:

Paper Testing Committee	T 481 sm
Packaging Materials Testing Committee	T 482 m
Acid Pulping Committee	O 300 p*

* Formerly O 406 p.

Change in Committee Personnel

Bourdon W. Scribner died on March 6. Known to his many friends as Don, he had been a member of the Standards Committee for many years. His long experience in paper and his ready access to others in the National Bureau of Standards made him a particularly valuable member. His passing was a severe loss both to his personal friends and to his colleagues. We all miss you, Don.

B. L. Browning of the Institute of Paper Chemistry was appointed a member of the committee in August.

Questions and Comments

In last year's report (*9*) a number of suggestions were offered for improvements in committee work and in service to TAPPI members. While it appears that they had little any effect, another small batch is now offered in the hope that they will eventually bear fruit and not be considered merely a bunch of sour "gripes."

1. A proposed method for Water Vapor Permeability of Packages was submitted by the Container Testing Committee in November for comment. The question has been raised as to whether this is within the scope of the Container Testing or of the Packaging Materials Testing Committee. Since the scope of each of these committees as given in the 1952 *Year Book* mentions "packaging, including packages" and "packaging materials and packages other than heavy containers," respectively, it would appear that these scopes need more precise definition. It is suggested that the scope of every committee be approved by the General Chairman of the Division in which it falls.

2. One of the most important phases of Standards, and the most neglected, is keeping them up to date. It seems worthwhile, therefore, to reiterate the following statement from last year's report:

All Standards and Suggested Methods over 5 years o

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Digester Linings for Calcium, Ammonia, Soda and Magnesia Base
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should be reviewed as soon as possible by the sponsoring committee. Those which the committee decides do not need any major revision should be designated as "reapproved" and such action should be communicated to the Chairman of the Standards Committee together with any changes in wording that may be recommended. Each Standard which requires revision should go on the committee's list of projects and be assigned a new project number.

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2. *Tappi* 35, No. 12: 129A (Dec., 1952).
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4. *Tappi* 35, No. 8: 145A (Aug., 1952).
5. *Tappi* 35, No. 9: 176A (Sept., 1952).
6. *Tappi* 35, No. 8: 147A (Aug., 1952).
7. *Tappi* 35, No. 5: 183A (May, 1952).
8. *Tappi* 35, No. 12: 128A (Dec., 1952).
9. *Tappi* 35, No. 2: 81A (Feb., 1952).

ROGER C. GRIFFIN, *Chairman*

Research Appropriations Committee Report—1952

Thirteen requests for financial aid were received from Association committees during 1952, and of these, eleven were granted, totaling $28,451.60. This is the largest fund for committee projects that has been approved, within a single year, by the Research Appropriations Committee. The requests, however, came from only ten committees of the more than 40 major committees listed in the *TAPPI Year Book*. The availability of research funds to assist and accelerate work on projects should be a stimulus to greater effort on the part of committee chairmen to further their objectives and those of the Association.

As a source of project material for committee activities, each chairman has been supplied with a copy of the A.P.P.A. booklet on "Technical Problems of the Pulp and Paper Industry" (Report No. 4, Committee on Coordination of Research). This informative report was also reprinted in the September, 1952, issue of *Tappi* (page 14A).

The list of 1952 research grants is summarized in the following table:

Request No.	*Project*	*Committee*	*Amount*
37	Friction Loss of Paper Stock in Pipes	Hydraulics	$ 6,275
40	Development of a Standard Method for the Determination of Suspended Solids in Mill Waste. A Comparison of Buchner and Gooch Methods	Water	$ 1,500
41	Construction and Testing of Two Drainage Time Testers of New Design	Structural Fibrous Materials	$ 512.60
42	Purchase, Alteration, and Evaluation of a Baumgartner Sphere for Measurement of Light Reflection from Insulating Board Finishes and Coatings	Structural Fibrous Materials	$ 1,364
43	Species Identification of Wood and Wood Fibers	Fibrous Materials Testing	$ 2,500
44	Study of North American Barks of Interest to the Pulp Industry	Fundamental Research	$ 4,500
45	Cellulose Viscosity Methods (continued project)	Chemical Methods	$ 1,800
46	Correlation Between Lignin Content and Chlorine Number of High Yield Kraft Pulps	Alkaline Pulping	$ 2,500
47	Thermodynamic Properties of Ammonium and Magnesium Bisulphite Solutions (continued project)	Acid Pulping	$ 2,000
48	Method for Determination of Chain Length Distribution of Cellulose	Chemical Methods	$ 500
49	Friction of Paper Stock in Pipe Lines (continued project; see no. 37)	Hydraulics	$ 5,000
		Total	$28,451.6

With respect to the publication of project reports finance as a whole or in part by TAPPI funds, a policy has bee developed whereby such reports before publication must b approved by a Review Committee comprising (1) the chai man of the sponsoring committee, (2) the general chairma of the respective division, and (3) the chairman of the Re search Appropriations Committee. Moreover, any suc published report should contain a credit line to the effe that the work was aided by TAPPI research grant. Annua progress reports are requested of all committees operatin under TAPPI grants. A summary of the active project received to date is attached to this report.

Information relating to "Regulations Governing Researc Appropriations" is found in the *Year Book*.

The present members of the Research Appropriations Com mittee are:

K. P. Geohegan (*ex-officio*)
G. H. Pringle (*ex-officio*)
Allen Abrams (1953)
A. E. Bachmann (1953)
H. W. Bialkowsky (1953)
W. F. Gillespie (1954)
J. W. Hemphill (1954)
J. D. Malcolmson (1954)
A. L. Sherwood (1955)
W. H. Swanson (1955)
J. L. Parsons, *Chairman*

Progress Reports

Research Grant No. 30—A Study of the Sugars Obtained b Hydrolyzing the Skin-Like Substance Obtained as a Insoluble Residue by Treatment of Pulp Fibers with Cu prammonium Hydroxide. Fundamental Research Com mittee.

The first report on this work was sent to members of th Committee in 1952, and subsequently published in *Tapp* 35, No. 11: 139A (Nov., 1952) under the title, "A Chemic Study of the Skinlike Substance of Sulphite Pulps." I brief, two different bleached coniferous sulphite pulps we subjected to treatment with cuprammonium hydroxid baxlooning ensued, and the major portion of the pulps di solved. The insoluble banded areas were isolated, deco perized with cold, aqueous HCl, and filtered. The filtrat when precipitated with acetone, gave a polysaccharide, whic when hydrolyzed yielded mannose and glucose (in the a proximate ration of 5:1). There was also some evidence uronic acid (the nature of which has not been determined No such polysaccharide could be isolated from an aspe sulphite pulp.

Unpublished, preliminary tests have been made with Mitscherlich pulp, submitted to a preliminary, hot wat extraction. The resulting aqueous extract, when hydrolyze gave glucose, xylose and mannose (in the approximate ratio of 6:17:22). The sulphite pulp remaining after the aqueo extraction was treated as before with cuprammonium h droxide, and the insoluble copper complex subjected to th usual decopperization, filtration, and precipitation technique Hydrolysis of the resulting polysaccharide yielded dom nantly mannose (mannose to glucose ration 17:3).

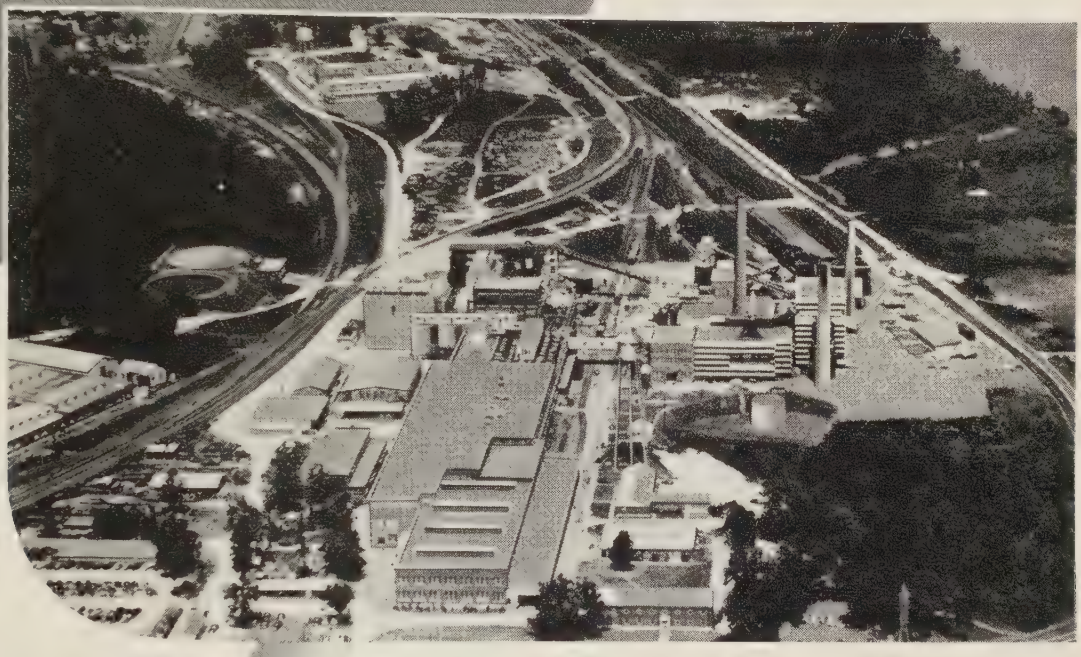
In future work we propose to study other pulps* by th usual techniques. Furthermore, we shall attempt a parti mechanical separation of the outer layers of the pulp (i.e skin substance) without recourse to peptization by chemic means, and to subject this material to hydrolysis and quant tative study, in the hope of finding whether this also retai largely mannose units.

The isolated skin substance (obtained by cuprammoniu

* Preliminary experiments with a bleached spruce kraft pulp indica that the "skin substance" from this material (obtained in very small amoun yields predominantly mannose together with smaller amounts of gluco galactose, and uronic acid.

designs...constructs

FOR THE PULP AND PAPER INDUSTRY



ograph shows the modern HOLLINGSWORTH & TNEY Kraft Pulp and Paper Mill in Mobile, ama.

original plant was built by Rust in -'41. New additions, completed in , were constructed by Rust to nearly le the output.

ique feature is the Bleach Plant, ned and constructed by Rust, dying for the first time the ng Forms principle of blithic concrete con- tion.

Rust plays a leading role in the expansion of the nation's pulp and paper making industry. Facilities in which Rust has participated, located in 16 states, represent total annual production well in excess of 1,000,000 tons.

These mills utilize both sulphate and sulphite processes in the manufacture of pulp, paper, wall board, felt and insulating materials, also dissolving pulp and synthetic fiber.

Other applications of Rust know-how are found in such auxiliaries as power plants, bleach plants, wood yard and water supply facilities, by-product chemical plants and efficient disposal. Allied industry activities include bag, paper box and other manufactured products.

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hydroxide) will be subjected to further purification with a view toward approaching a "pure" mannan. (Such a product, isolated by a different technique, was claimed by Hessand Ludtke, *Ann.* 466:18 (1928) but has hitherto not been substantiated.) The significance of mannose units in hemicelluloses used as beater additives in improving pulp quality is being explored in another project.

Research Grant No. 31—Evaluation of the Dye Adsorption Method of Determining the External Specific Surface of Pulp. Fundamental Research Committee.

Results of a portion of the investigation show that alkaline pulps do not yield the same type of adsorption isotherm as is observed with sulphite pulps. This is due to the type of cook and not the type of wood. A good correlation of specific dye adsorption with physical properties of pulp handsheets is shown by all pulps. No correlation is evident, however, when pulps from different cooks or of differing botanical species are compared.

Decrease in dye adsorption of softwood pulp on drying and subsequent resoaking appears to be of the same order of magnitude as the decrease in strength properties known to occur under such a condition. Cupriethylenediamine disperse viscosities of six different commercial sulphite pulps appear to correlate fairly well with the specific dye adsorption values of these pulps. Changes in dye adsorption are related to the changes in physical properties of any given pulp during beating. Furthermore changes in dye adsorption parallel changes in physical properties of sulphite pulp during properly controlled bleaching. Data on effect of drying on specific adsorption are now being obtained.

Research Grant No. 32—Determination of the Effect of Rate of Loading in the "Flexural Resistance and Deflection of Fiberboard" Test. Subcommittee S-5 of the Structural Fibrous Materials Committee.

Testing work at the Forest Products Laboratory has been completed and a report submitted to Subcommittee S-5. A tentative agreement has been reached within the subcommittee on a testing speed corresponding to approximately one minute testing time. The next step, which is about to begin, will be a round-robin test in the laboratories of the various members of the subcommittee using the new testing specification. If approval is still indicated after completion of the round-robin tests for the technique selected a final specification and report can be made. This problem should be completed during 1953.

Research Grant No. 33—Determination of a Method of Test for the Racking Strength of Insulating Board Sheathing. Subcommittee S-7 of the Structural Fibrous Materials Committee.

Progress has been slow in this subcommittee. The shaping of a program has been the chief cause of a lack of results. The group has, however, begun to get some agreement on the testing program and should show more activity during 1953.

Research Grant No. 35—The Construction and Testing of a Test Board Forming Machine for Insulating Board. Subcommittee S-3 of the Structural Fibrous Materials Committee.

The main delay in moving this problem along has been the gathering together of necessary equipment. Some items were under government priority. The Board Former was completed and delivered some time ago and used in testing work by Subcommittee S-10 at Bauer Brothers Laboratory while waiting for the pump. Subcommittee S-10 will present a report at the Annual TAPPI Meeting on the results they have obtained. Subcommittee S-3 will be in a position shortly to begin their program. Two years is the estimated time to complete the task.

Research Grant No. 41—Construction and Testing of Two Drainage Time Testers of New Design. Subcommittee S-4 of the Structural Fibrous Materials Committee.

Two Drainage Time Testers have been completed and tested at Forest Products Laboratory and the Flintkote Laboratory. In general the Drainage Time Testers were very satisfactory. The valve design, however, was faulty in that air was trapped behind the valve gate after each test. This air would lead slowly past the valve at the beginning of the next test causing the stock level in the testing tube to fall so that a zero position could not be maintained while preparing for a test. A new valve type has been located that will eliminate the difficulty. The Drainage Time Testers will be revamped and the tests repeated. Drainage Time Testing will be the subject of a Panel Discussion at the coming annual TAPPI meeting in New York.

Research Grant No. 42—Purchase, Alteration and Evaluation of a Baumgartner Sphere for Measurements of Light Reflection from Insulating Board Finishes and Coatings. Subcommittee S-8 of the Structural Fibrous Materials Committee.

A Baumgartner Sphere has been borrowed by the subcommittee and tested at Johns-Manville Research Center. Results indicated several changes were necessary. As the loaner would not allow changes in his instrument it was decided to purchase one for alterations. A Baumgartner Sphere has been purchased and alteration parts ordered. When these parts are available they will be applied and tested. The corrected sphere will then be sent to the Armstrong Cork Co. laboratory in Lancaster, Pa., for comparison with two other types of instruments at that laboratory. Problem should be completed in 1953.

Research Grant No. 44—Study of North American Barks of Interest to the Pulp Industry. Fundamental Research Committee.

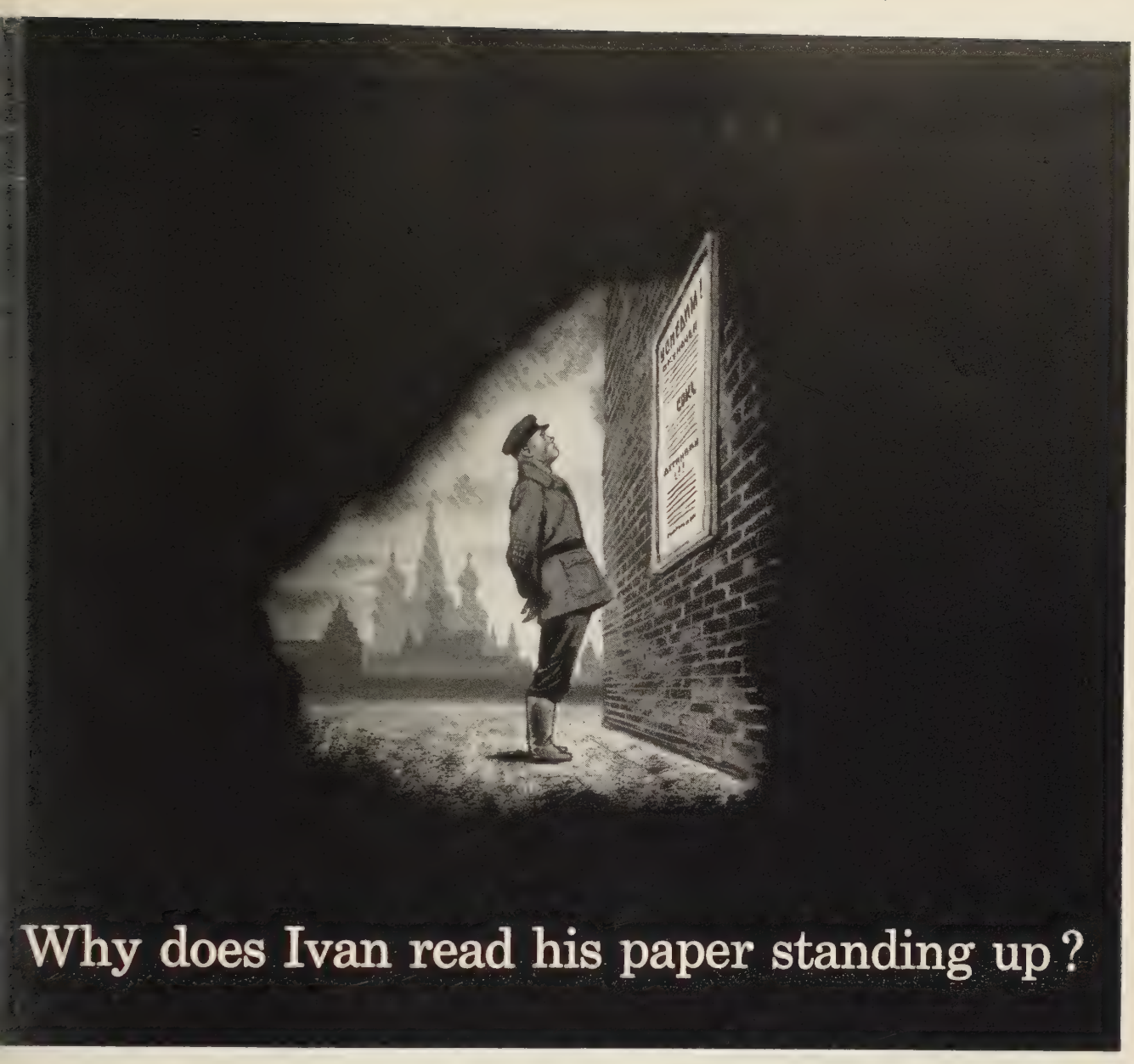
Collection and handling of material: A special trip was made to the Northern part of Wisconsin for collecting the local pulpwood species and arrangements have been made for obtaining other specimens from different regions in this country. According to the proposed list of species to be studied, most of the coniferous barks have been collected, together with some of the required hardwood barks. Fresh barks of each species were cut from three trees. The specimens are preserved in three ways, namely, in fixing solution, in 65% moisture room, and in air-dry condition.

The present approach to this investigation: Coniferous barks will be studied first, followed by the hardwoods. By the improved and simplified microtechnique, about 300 permanent microscopic slides of section and macerated barks from the newly collected material have been prepared. Since this project started, the bark structures of *Abies balsamea, Picea engelmanii, Picea mariana, Tsuga canadensis,* and some southern pines have been examined. Based upon the observation of all tissues from the cambial region to the outermost part of a given bark, cell types, their arrangement, size and relative volume are being noted. Particular attention has been paid to the structural characteristics of the bark in relation to the properties of fibrous material for pulping. Preparation of microchemical tests has been started. The first phase of this study would be a morphological view rather than a pure chemical analysis, and particularly in respect to some substances which are significantly different from those in wood.

Research Grants No. 37 and No. 49—Friction Loss of Paper Stock in Pipes. Hydraulics Committee.

Thus far it has been shown that there is a mathematical relationship between the pipe friction of a given stock at a given consistency in different size pipe lines; there is a definite mathematical relationship between pipe friction at different velocities in the same size pipe; and there is a definite mathematical relationship between pipe friction for different consistencies in the same size pipe.

A laboratory instrument has been designed and built to



Why does Ivan read his paper standing up?

THIS is the way a Russian must read his newspaper, if he can read at all. That's because Russia does not produce enough newspapers to supply everyone who wants them.

Actually, Russia's per capita consumption of paper of all kinds is about 35 pounds a year. Here in our own country, each man, woman and child accounts for nearly 400 pounds of paper annually . . . more than 10 times the Russian consumption. Amazingly, American paper consumption has jumped 62% just since 1945!

Don't these figures suggest why America's educational level is so superior to that of Ivan and his compatriots? And doesn't that, in turn, pay tribute to the American paper and pulp industry, and its resourcefulness in meeting the tremendously increased demands for paper?

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give a friction factor for any given stock that can be applied to any piping system to indicate what the friction loss will be in that system for that stock. This instrument is now in operation at the University of Maine.

A one-pipe friction loss measuring system has been built at the University of Maine using equipment loaned or given to the University by various interested companies in the industry. This equipment can be conservatively valued at $10,000. We are now in the process of checking pipe friction in this system against the friction factors obtained from the laboratory instrument to prove whether or not there is a correlation. We estimate that this work will take two years and cost approximately $9000.

It is our hope that TAPPI will not have to grant any more money for this project. We are now working with the Hydraulics Institute with the hope they will contribute the remaining $5000 necessary to complete this project.

It is planned to present an interesting progress report at the 1953 Engineering Meeting of TAPPI at Montreal.

Research Grant No. 40—Development of a Standard Method for the Determination of Suspended Solids in Mill Waste. A Comparison of Buchner and Gooch Methods. Water Committee.

Work on this project has been carried out at The Institute of Paper Chemistry, under the guidance of B. L. Browning.

A number of determinations of total fixed and suspended solids were made on two types of mill waste, kraft mill and deinking, under a variety of conditions. The data obtained do not show that significant differences are obtained when using the Buchner funnel as compared to the Gooch crucible method, for the two wastes studied.

As a continuation of the work, it is suggested that the two methods (Gooch crucible vs. Buchner funnel) be compared on a variety of wastes from different sources and representing different types of operation.

Research Grant No. 47—Thermodynamic Properties of Ammonium and Magnesium Bisulphite Solutions. Acid Pulping Committee.

1. Research has been continuing on determination of equilibrium data for the system ammonia–sulphur dioxide–water under a TAPPI Research Fellowship at the University of Washington which has been granted to the Acid Pulping Committee.

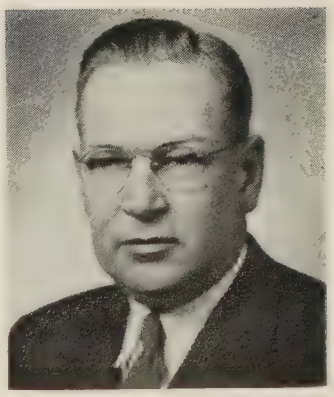
2. In Report I there were submitted equations which had been developed for correlating equilibrium data in the system ammonia–sulphur dioxide–water. The constants shown in these equations were developed by careful consideration of all experimental data available in the literature. Similar correlation was shown to be possible for the systems magnesium–sulphur dioxide–water, calcium–sulphur dioxide–water, and sodium–sulphur dioxide–water.

3. While these equations should be immediately useful for predicting vapor-liquid equilibrium data within certain ranges of concentration and temperature, there are other ranges for which data do not exist. Thus, recent work has been directed toward the securing of experimental measurements in these ranges.

4. After careful consideration, it has been decided that the radioactive "tracer" method will be the most accurate and rapid one to obtain the data needed. Thus work is steadily going forward to set up and operate the necessary apparatus.

5. On completion of the evaluation of equilibrium data, semiworks scale absorption studies will be initiated.

6. Application has been made to the Isotopes Division of the Atomic Energy Commission for authorization to use radioactive isotopes, and an order has been placed with Tracerlab, Inc., for 10 millicuries of radioactive S^{35}. For this work a "hot lab" has been established in the Chemical Engineering Department of the University of Washington.



George H. Pringle, Mead Corp., President of TAPPI

Karl O. Elderkin, Bowate Southern Paper Corp Vice-President of TAPPI

Research Grant No. 45—Cellulose Viscosity Methods. Sub committee on Disperse Viscosity of Chemical Method Committee.

The work under this grant is under the jurisdiction A. F. Martin, Chairman of a TAPPI Subcommittee on Di perse Viscosity. He is also Chairman of the correspondin committee in ACS and ASTM. The work on the grant being done by Mr. Browning and cooperators at The Institut of Paper Chemistry, Appleton, Wis.

Mr. Martin has reported to the TAPPI committee i February, 1952 (see report in June, 1952, *Tappi*, pag 105A) and to the Testing Division Meeting in Syracuse i September, 1952 (see *Tappi*, November, 1952, page 117A Mr. Martin also reported to an ACS Subcommittee in Apr and to a joint ACS-ASTM group in September.

Mr. Martin also has a group of approximately 25 authoritie in disperse viscosity to which he has sent plans for the wor of this project. They have received copies of Mr. Browning report and made extensive comments on the work thus fa completed. This program of cooperation and consulting is very important part of our subcommittee work. When M Martin has a revision to propose it will be acceptable to TAPP ACS, ASTM as well as several large groups of cellulose autho ities of this country and abroad.

The work of this past Fall will be reported to the Chemic Methods Committee on February 16 by Mr. Martin.

Research Grant No. 48—Method for the Determination of th Chain Length Distribution of Cellulose. Chemic Methods Committee.

Research under this grant has just started (Decembe 1952) under Mr. G. Broughton at the University of Rocheste Rochester, N. Y.

Thus far Mr. Broughton has assembled equipment neede for chain length measurement and has prepared a survey the literature. This survey will be presented as a paper the TAPPI meeting on Thursday morning, February 1 The plans for the laboratory work will be outlined before th Chemical Methods Committee on Monday, February 16.

JOHN L. PARSONS, *Chairman*

Report of the Tellers Committee

John H. Doherty of the Union Bag & Paper Corp. and Chai man of the Tellers Committee, reported on the results of th mail ballot for election of Association Officers and Executiv Committeemen. His associates on the committee we Henry Perry, of the American Paper & Pulp Association an William K. Metcalfe of the J. O. Ross Engineering Co., a of New York City. The committee reported as follows:

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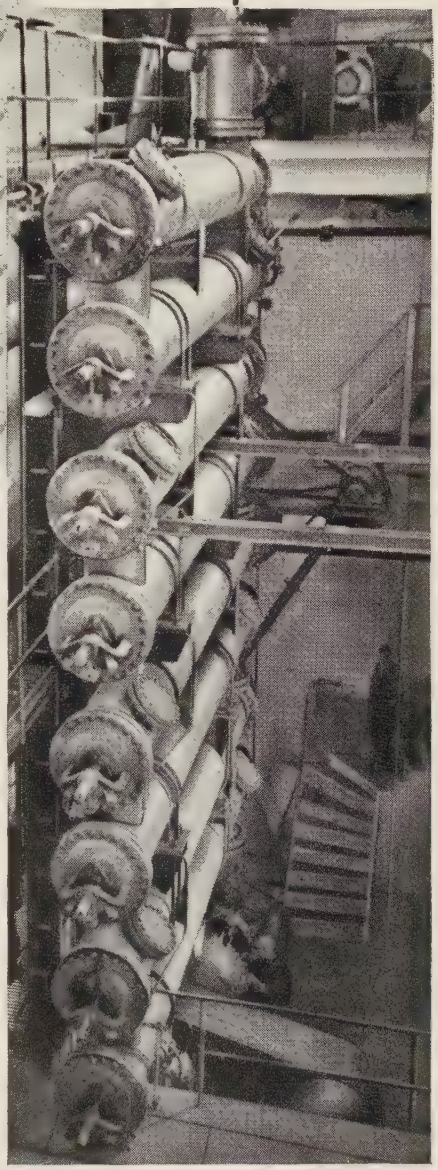
continuous digester



More and more mills using CHEMI-PULPER continuous digesters for their around-the-clock pulp mill operation report the continuous production of uniform, high grade pulp at the lowest possible cost.

CHEMI-PULPER continuous digesters have been built in sizes from 2 to 8 tubes with various diameters. The largest of these units are capable of producing over a 100 tons of pulp per day. Some are equipped with the new Pandia Discharger which continuously and uniformly discharges pulp at a constant rate from the CHEMI-PULPER continuous digester to the atmosphere.

The 8-tube CHEMI-PULPER continuous digester shown here is an installation in Finland which was placed in operation during the Summer of 1951 and feeds primarily on waste spruce and pine from a sawmill. This unit is fabricated of 316 stainless steel which permits the use of alkaline or acid cooking liquors. Because of the CHEMI-PULPER continuous digester's basic construction and flexibility of operation, the 8-tube unit can produce pulps over a wide yield range.

CHEMI-PULPER continuous digesters are being used universally to convert hard or soft woods or mixtures of these woods into superior pulps for insulating board, flooring, roofing and automotive felts, and .009 corrugating and other types of boards and papers.

One of Pandia's engineers will be glad to consult with you concerning plans for new plant construction or for improving present pulp mill operation.

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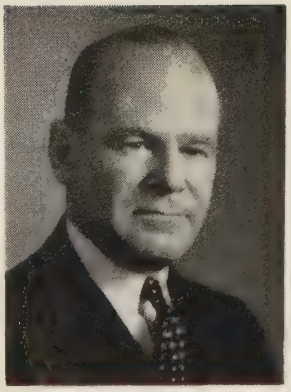
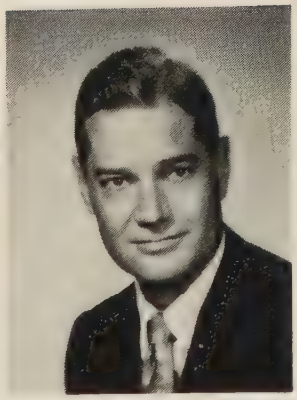


John Buss, Provincial Paper, Ltd.



Harry C. Moore, Beloit Iron Works

Charles J. Sibler, West Virginia Pulp & Paper Co.

We the members of the Tellers Committee, having made a canvass of the official ballot for officers and members of the Executive Committee for 1953 of the Technical Association of the Pulp and Paper Industry, have found that the following have received a majority of the 1181 votes cast.

President: George H. Pringle, Mead Corp., Chillicothe, Ohio.
Vice-President: Karl O. Elderkin, Bowaters Southern Paper Corp., Calhoun, Tenn.
Executive Committeemen (to serve three years): Norman I. Bearse, Champion-International Co., Lawrence, Mass.; John Buss, Provincial Paper, Ltd., Toronto, Ont., Canada; Harry C. Moore, Beloit Iron Works, Beloit, Wis.; Charles J. Sibler, West Virginia Pulp and Paper Co., New York, N. Y.

TAPPI 1953 Executive Committee

As reported by the Tellers Committee, George H. Pringle and Karl O. Elderkin were elected President and Vice-President, respectively, of the Technical Association.

Members of the committee whose terms continue are W. D. Harrison, Riegel Paper Corp., Milford, N. J., W. F. Holzer, Crown Zellerbach Corp., Camas, Wash., W. F. Hathaway, Kalamazoo Vegetable Parchment Co., Kalamazoo, Mich., R. P. Price, Hammermill Paper Co., Erie, Pa., G. A. Day, Brown Co., Berlin, N. H., H. F. Lewis, Institute of Paper Chemistry, Appleton, Wis., L. K. Burnett, Ohio Boxboard Co., Rittman, Ohio, and J. R. Lientz, Union Bag & Paper Co., Savannah, Ga.

The members whose terms expired in February, 1953, were K. O. Elderkin, Milton Jacobs, Chas. T. Main, Inc., Boston, R. W. Kumler, American Cyanamid Co., New York, N. Y., and George E. Shipman, Donnacona Paper Co., Donnacona, Que.

Following are brief biographies of the individuals elected to serve the Association as members of the Execuitve Committee for the next three years.

Norman I. Bearse, Vice-President of The Champion-International Co., Lawrence, Mass. was born in Laconia, N. H., in 1898 and graduated from the University of New Hampshire in 1921, following which he joined the Nashua Gummed and Coated Paper Co., Nashua, N. H., as a Development and Research Chemist. In 1929 he became Plant Chemist for the Lowe Paper Co. in Ridgefield, N. J., and in 1936 he joined The Champion-International Co. in Lawrence, Mass., as Technical Director. In 1942–43 he was Chairman of the TAPPI New England Section.

John Buss, Assistant to the General Manager of Provincial Paper Ltd., Toronto, Ont., was born in Kalamazoo, Mich., in 1899 and graduated from Queens University at Kingston, Ont., in 1919, and from the Massachusetts Institute of Technology in 1926. Prior to joining Provincial Paper, Ltd. in 1931, he was employed by The Wayagamack Pulp & Paper Co., Three Rivers, Que., Ha Ha Bay Sulphite Co., Port Alfred, Que., Bogalusa Paper Co., Bogalusa, La., Arthur D. Little, Inc., Cambridge, Mass., and the Nashua Gummed & Coated Paper Co., Nashua, N. H. He served three years on the Executive Council of the Technical Section, Canadian Pulp and Paper Association, and for one year (1949) as its Chairman.

Harry C. Moore, President of the Beloit Iron Works, Beloit, Wis., was born in Atlanta, Ga., in 1913 and graduated from Northwestern University in 1935. He worked for the Chicago *Daily News* until the end of 1936 at which time he joined The Beloit Iron Works, working successively in the foundry, machine shop, erecting floor, and the sales department. In 1943 he was made Vice-President and President in 1952. At the present time he is President of The Pulp and Paper Machinery Association and was a member of the NPA and OPS Industry Advisory Committees.

Charles J. Sibler, Chief Engineer of the West Virginia Pulp and Paper Co., New York, N. Y., was born in Zurich, Switzerland, in 1896 and graduated from the Swiss Federal Polytechnic Institute as a mechanical engineer. In 1920 he came to the United States where he worked with Westinghouse Electric Co., public utilities, and the Foster Wheeler Corp., specializing in design, application, and sale of steam turbines, condensers, steam generators, and complete steam power stations. He joined the West Virginia Pulp and Paper Co. in 1936 as Supervisor of Power and was appointed Chief Engineer for the company in 1945. In TAPPI he has been Chairman of the Steam and Power Committee and in 1951 became General Chairman of the Engineering Division. He has been active in the American Society of Mechanical Engineers, in which he represented the pulp and paper industry in its Air Pollution Committee and has been a member of the ASME Boiler Code Committee. He is also a member of the New York State Society of Professional Engineers, the American Concrete Institute, and Alumni Association of the Swiss Federal Polytechnic Institute.

Report of the Joint Textbook Committee

The Joint Textbook Committee of the Paper Industry consists of Harry S. Spencer, Howard Smith Paper Mills, Beauharnois, Que., Chairman, R. S. Hatch, Hudson Pulp & Paper Co., Palatka, Fla., Douglas Jones, Technical Section, Canadian Pulp and Paper Association, Montreal, Que., R. G. Macdonald, TAPPI, New York, N. Y., and R. S. Kellogg, Palmetto, Fla., Secretary. J. Newell Stephenson, Gardenvale, Que., is Editor.

Statistically, the activities of the committee during 1952 are summarized as follows:

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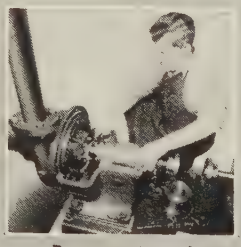
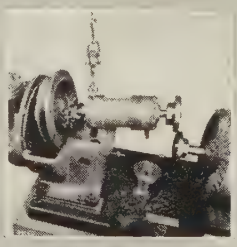
LIQUOR PUMPS

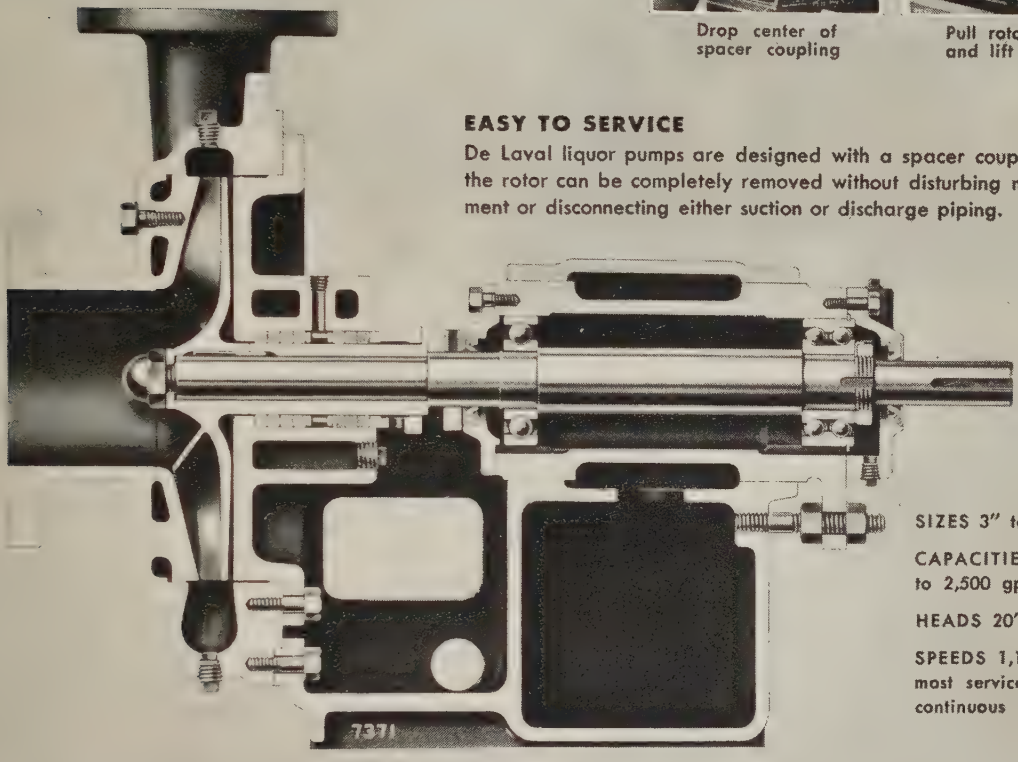
for tough recovery mill service



Drop center of spacer coupling



Pull rotor back and lift out



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SIZES 3" to 6"

CAPACITIES 100 gpm to 2,500 gpm

HEADS 20' to 150'

SPEEDS 1,150 rpm for most services requiring continuous operation

- **One piece suction nozzle with single joint minimizes leakage.**
- **Eductor vanes on back of impeller relieve stuffing box pressure.**
- **Rotor can be adjusted with external adjusting screw to compensate for wear.**
- **Oil mist lubrication minimizes bearing friction.**
- **Extra deep stuffing box has inlet and outlet water seal connections and inlet and outlet stuffing box cooling connections.**
- **Suction liner is easily and inexpensively renewed.**
- **Heavy stiff shaft withstands severe operating conditions.**

The important design features, shown above, explain why De Laval type CL Liquor Pumps (1) take the punishment of tough recovery mill service for years; (2) cut maintenance costs.

These pumps are especially designed to handle "tough" *corrosive* or *erosive* liquids such as hot or cold acids, alkalies, digester liquors, milk of lime, etc. What's more, De Laval Liquor Pumps are easy to get at for servicing, thus substantially reduce downtime.

Write for Bulletin 1100 giving full application and specification data on De Laval pumps for the paper industry.

DE LAVAL *Liquor Pumps*

DE LAVAL STEAM TURBINE COMPANY

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DL142

Finances

Receipts:		
Cash on hand Jan. 1, 1952	$ 420.93	
Royalties during the year	5603.71	
		$6024.64
Expenses:		
Salaries	$3200.00	
Revision expenditures	1269.21	
Miscellaneous	219.46	
		4714.16
Assets (Jan. 1, 1953):		
Cash in bank		$1310.48

Textbook Sales

Sales of textbooks during the year totaled 1186 volumes. Details by volumes and the grand total since the publication of the first volume of the first edition in 1921 are as follows:

	1952 Sales	*Grand total*
First three editions:		
Volume I	38	6,335
Volume II	Out of print	5,511
Volume III	None	15,339
Volume IV	None	12,673
Volume V	67	11,343
Total	105	51,201
Fourth edition:		
Volume I	556	4,675
Volume II	525	1,723
Total	1081	6,398
Grand total since 1921	57,599	

It takes much longer to get out a book now than it did 30 years ago. The manuscript of Volume III of the latest edition was submitted to the publisher, Dec. 31, 1951, and the first set of galley proofs came 10 months later, page proofs are now being checked and returned. Volume I carried 1043 pages, Volume II, 587 pages, and the indications are that Volume III will have about 950 pages with 400 illustrations, nearly half of which are new drawings.

The manuscript is practically all written for Volume IV—the final one of the present series—there must be considerable editorial work before submission to the printer. It looks as if the present committee might just about complete its thirty-sixth year of activity with the publication of Volume IV.

The committee is deeply grateful to the many individuals, companies, and organizations without whose wholehearted and generous cooperation the composition of these volumes through so many years would have been wholly impossible. Even the list of their names is beyond the limits of this Report, but the world-wide pulp and paper industry, of which we are proud to be a part, is forever, in their debt.

We are especially fortunate and happy in the association with McGraw-Hill Book Co. as our publishers for a third of a century. Their high standards have been an important factor in the success of this international cooperative undertaking.

And all praise is due Editor Stephenson who has been on the job every minute since the organization of the committee September, 1918. It has been a long pull and Steve has always had a sure hand on the oar.

ROYAL S. KELLOGG, *Secretary*

TAPPI Editorial Board

It will be noted on the Contents or masthead page of this magazine that there are 23 members of the Editorial Board, including the Chairman (C. J. West, now deceased). The dates following their names indicate the final year of their three-year terms. The names were originally arranged alphabetically in 1949.

To permit more members of the Association to serve on the Board, Dr. West agreed to the suggestion by the Editor that individuals whose terms expire each year should leave the Board unless certain special consideration indicate the desirability of reappointment.

The first change in the Board membership since 1948 was made with the February, 1953, issue of *Tappi*. Members leaving the Board were S. I. Aronovksy, J. F. Campbell, J. d'A. Clark, E. L. Cowan, R. F. DeLong, A. S. Erspamer, and R. C. Griffin.

The new members, whose terms continue through 1955, are B. L. Browning, K. W. Britt, R. F. DeLong, E. M. Jenkins, E. C. Lathrop, C. C. Porter, and C. J. Sibler. Since each member of the Board is a member because of his specialized knowledge regarding specific aspects of pulp and paper literature, the replacements are made on an individual basis, each new Board member having interest corresponding to individual retiring members, such as engineering, water, fibrous agricultural residues, structural fibrous materials, microbiology, wet-strength, and testing in the present reorganization.

C. E. Libby Honored

At the TAPPI Annual Meeting the alumni groups of the University of Maine and the College of Forestry, State University of New York, held a joint alumni luncheon on Wednesday, February 18, at the Roosevelt Hotel to honor Professor C. E. Libby, now head of the Papermaking Course in the College of Forestry at the North Carolina State College. Prof. Libby graduated from Maine in 1916 and later became head of the Pulp and Paper Course at the New York State College of Forestry at Syracuse.

Conference on Application of Statistical Methods

A conference on the application of statistical methods to the problems of the pulp and paper industry will be held under the cosponsorship of TAPPI and Western Michigan College, June 15–26, 1953. Its first purpose is to acquaint paper mill personnel with the applicability of statistical methods to their problems. Secondly, it is designed to give preliminary training to those individuals so that they may use statistical methods in research, production, and quality control.

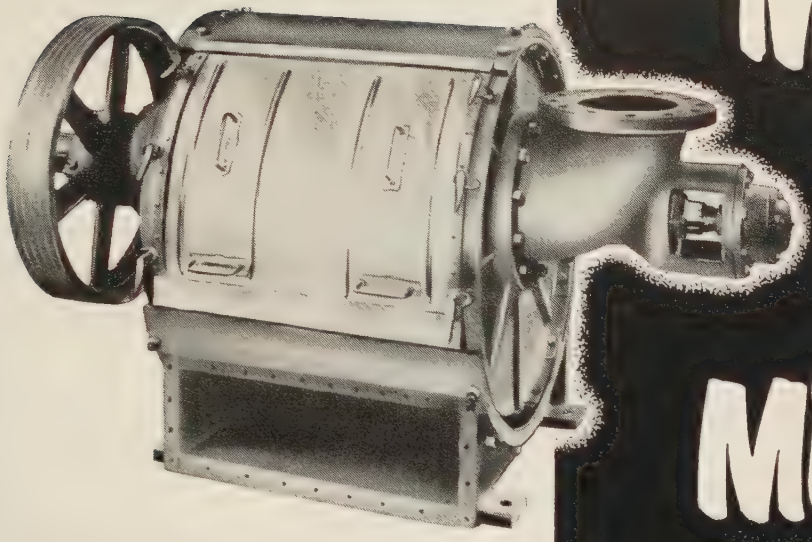
The conference will consist partly of regular lecturers, and laboratory periods, when there will be discussed the routine of applying statistical methods to mill problems. Secondly, speakers, from the industry, will discuss their experience with such applications. The outline of the course is attached.

The program will be conducted by four regular lecturers: Prof. Geoffrey Beall of the University of Connecticut, formerly of the Institute of Paper Chemistry; Dr. Charles A. Bicking, Research and Development Div., Ordnance Dept., formerly with Hercules Powder Co.; Dr. Charles H. Butler and Dr. Fred Beeler, Mathematics Dept., Western Michigan College. Eight evening talks by men for industry will be given. Outside speakers will include: O. H. Somers, of Western Printing & Lithographing Co., Racine, Wis.; Fred R. Sheldon, Buffalo Electro-Chemical Co., Buffalo, N. Y., and R. T. Trelfa, Watervliet Paper Co., Watervliet, Mich.

The conference is, essentially, planned for men with university degrees. It will be given only if 35 enroll but no more than 50 will be accepted, in either the first week (elementary) or the second week (more advanced) sections.

The regular lectures and laboratories will be given in the morning, 9:00 a.m. to 1:00 p.m. The talks on personal experience on application will be given in the evening. The afternoon will be free for recreation, for discussion of the morning's work with the lecturers, or for discussion of other problems with the lecturers as shown on the program.

Those wishing to attend may register for either week, with



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The "Junior" Screen is a quarter-sized model of the big Mark "A", with a rated capacity of 1400 U.S.G.P.M. accepted stock. 25 h.p. operates the "Junior" Screen, but it will handle motors up to 40 h.p. Greatest applications are as secondary screening units, and as a primary screen for mills producing a variety of pulp grades which require a system made up of small, separate units.

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a fee of $100 or for both weeks with a fee of $200. Fees include room and board.

The men attending the statistical conference will be by themselves in one of the college dormitories. The college will provide maid service, easy chairs, desk lamps, etc., in addition to its regular services and equipment. There will be a room for each man. All meals will be especially provided for the group and include waitress service.

In the case of men bringing their wives, the arrangements will depend upon how many such couples are involved. If there are few, they may have to shift for themselves in the town, which will be difficult. If sufficient wives are coming arrangements will be made to house them in one of the dormitories.

Those wishing to register should write to Prof. Charles H. Butler, Western Michigan College, Kalamazoo, Mich. Registration fees are payable in advance by check to Western Michigan College (but will be refunded by May 1, in case the registration is insufficient to justify the conference). The registration will be closed when it reaches 50 applications. Notices will be sent to all registered parties when the number reaches 35 and the conference is assured.

The following form should be completed and returned to Prof. Butler.

I. In connection with the forthcoming conference on application of statistical methods in the pulp and paper industry at Western Michigan College, I wish to be registered for (check off):

(a) The elementary week, June 15–19.
(b) The more advanced week, June 22–26.
(c) Both weeks, June 15–26.

II. I shall come (check off):

(a) Alone.
(b) With my wife.

III. I enclose (check or checks) of:

(a) $100 for one week alone.
(b) $140 for one week, including room and board for my wife.
(c) $200 for two weeks alone.
(d) $280 for two weeks, including room and board for my wife.

IV. I shall expect to be notified as soon as the registration is sufficient to assure the conference and not later than May 1, if it is insufficient. In the latter event, I shall expect my fees to be promptly refunded.

Signed_____

Program

First or Elementary Week, June 15–19, 1953

This week is designed particularly for participants who have not used statistics previously. Men with some experience are advised to consider only the second week of the conference. Thorough grounding is given in the basic frequency distributions encountered, in the test for significance of a difference, and in the application of control charts. An adequate basis is established for the second more advanced week which follows. Text: Grant, "Statistical Quality Control," 2nd ed. (1952), McGraw-Hill Co.

Monday, June 15, 1953

Lecture 1, Introduction—9:00–9:25 a.m.—C. H. Butler

Presentation of speakers, discussion of objective, discussion of registration, and housing.

Lecture 2, The Chance Variability of Measurements—9:30–10:20 a.m.—Geoffrey Beall

Illustrative data on basis weight, burst tests, etc., are presented. Variation in such data is presented as normal or Gaussian. The danger of nonnormality, which is effectively lack of symmetry, is discussed and the comparative normality of averages is stressed. The idea of variability as the necessary characteristic concomitant to average in a measured character is developed. The discussion is qualitative rather than mathematical. Thus, standard deviation is presented as the quantity embracing two thirds of the distribution. It is presented as a means of characterizing the variability. It is calculated from range and by sums of squares.

Suggested Reading: Grant, Chapter III (the first two chapters are introduction and a survey of some quality control techniques. It is suggested that they be read at leisure. The material in Chapter II will become clearer as the course proceeds).

Laboratory I, Character of the Normal Distribution—10:30–12:00 a.m.

(a) Individual observations on a property such as bursting strength are plotted as an illustration of variation of nonnormal character.
(b) The averages for groups of nine burst values are similarly treated.
(c) The medians of groups of nine are similarly treated.

Optional Afternoon Laboratory—Operation of Desk Calculators

Talk I—7:00–9:00 p.m.

Tuesday, June 16, 1953

Laboratory II, Calculation of the Standard Deviation and Its Use—9:00–10:50 a.m.

(a) Using the material of Laboratory I, the standard deviation is calculated for single items by the alternative methods of range and sums of squares.
(b) The standard deviation of means is calculated in contrast to that of items to illustrate the reduction in variability.

Lecture 3, Control Charts for Measurements (Individual Items and Means)—11:00–11:50 a.m.—C. A. Bicking

Illustrations of operations in control are taken from the previous material. Similar material that is out of control is presented. There is little argument as to underlying theory, but the method of finding the 0.05 (2-sigma) and 0.003 (3-sigma) limits is shown. The stress is on application.

Suggested Reading: Grant, Sections 65–77, pp. 75–100; Examples 1 and 2, pp. 17–28.

Laboratory III, The Application of Control Charts for Individual Items and for X Bar—12:00 a.m.–1:00 p.m.

For mill data both in and out of control there are plotted control charts.

(a) On individual items.
(b) On the average, X bar.

Optional Afternoon Laboratory, Calculation of Standard Deviation

Talk II—7:00–9:00 p.m.

Wednesday, June 17, 1953

Lecture 4, Control Charts for Range of Tests—9:00–9:55 a.m.—C. A. Bicking

Illustrations of operations where the variability, i.e., range, is in control. Further examples are provided where the range is out of control. Method of finding the 0.05 and 0.003 limits is shown.

Suggested Reading: Grant, Sections 78–83, pp. 100–107. (Chapters V through VII in Grant give an excellent discussion with examples of different ways that X bar and *R* charts may be used to advantage in a manufacturing process. It is suggested that the participants read these chapters at their leisure.)

Laboratory IV, The Application of Control Charts for Range, *R*—10:00–10:50 a.m.

For mill data both in and out of control there are plotted control charts on the range, *R*.

Lecture 5, Tests of the Significance of a Difference—11:00–11:50 a.m.—F. A. Beeler

The problem of deciding on the significance of a difference,

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particularly as it arises from experimental modifications of operations or as it occurs in the comparison of two competitive products, is tested by appeal to the normal distribution and by the use of "student's" *t*.

Laboratory V, Testing the Significance of a Difference—12:00 a.m.–1:00 p.m.

The significance of differences of paired data is tested alternatively by an appeal to the normal distribution and by the use of *t*.

Optional Afternoon Laboratory, Construction of Control Charts for X bar and *R*

Talk III—7:00–9:00 p.m.

Thursday, June 18, 1953

Lecture 6, The Chance Variation of Defects—9:00–9:55 a.m. —F. A. Beeler

Illustrations, number of sheets, per hundred, with slime spots, number of samples per gross with perforations, etc. Frequency distributions are shown. It is pointed out that the identity of these distributions with theoretical distributions (binomial) is independent of the problem and dependent only on the condition of random sampling. The general theory, the binomial probability expansion, is presented. It is pointed out that there are facilitating tables.

Suggested Reading: Grant, Sections 165–174, pp. 197–208.

Laboratory VI, The Calculation of Binomial Distributions—10:00–11:50 a.m.

Illustrations of attribute defects, similar to those calculated in lecture are given. The participants graph their results.

Lecture 7, Control Charts for Fraction Defective—12:00 a.m.–1:00 p.m.—Geoffrey Beall

Illustrations of operations in control taken from the previous material. Similar material that is out of control is presented. There is little argument as to the underlying theory, but the method of finding the 0.05 (2-sigma) and 0.003 (3-sigma) limits is shown. The stress is on application.

Suggested Reading: Grant, Sections 182–194, pp. 229–241; Example 3, pp. 28–32.

Optional Afternoon Laboratory, Significance Tests

Talk IV—7:00–9:00 p.m.

Friday, June 19, 1953

Laboratory VII, The Application of Control Charts for Defects—9:00–10:50 a.m.

(a) Control chart is plotted as class exercise from a ball-drawing experiment.
(b) Control charts are plotted, individually, from mill data, both in and out of control.

Lecture 8, How to Go About an Investigation in a Mill—11:00 a.m.–1:00 p.m.—C. A. Bicking

A plan is presented for introducing a quality control program in a going plant. Methods of presenting data are discussed. Control limits are related to tolerance limits. A brief summary of the topics covered during the week concludes the session.

Second or More Advanced Week, June 22–26, 1953

This week is particularly designed for participants who have previously used statistics to some extent; they are advised to consider only this week. Men who have attended the first week may profitably stay on. This second week, as can be seen below, is concerned with the elements of experimental design and the analysis of experimental results.

The text for this week is Dixon and Massey, 1952, "Introduction to Statistical Analysis," McGraw-Hill, New York. It will be distributed to the participants by the conference. From it, sections that should be read, preferably in advance, are indicated for the various lectures, as indicated below.

Since this second week presupposes some familiarity with statistical procedure, participants should prepare themselves by reading from the text, Ch. II, Ch. III (Sect. 1, 2), Ch. IV, Ch. V (Sect. 1, 2, 7, 8), Ch. VI (Sect. 1, 2), Ch. VII (Sect. 1), and Ch. IX (Sect. 8). It is hoped that the advance distribution of texts will allow everyone to go over this work.

It is planned, as during the earlier week of the conference, to conduct a series of informal laboratories in the afternoons. These will be arranged on request although some have been suggested below. The purpose of such laboratories is to give participants practice in such fields as they require. Those participants who do not need such practice will usually avoid these informal laboratories.

Monday, June 22, 1953

Lecture 9, Introduction—9:00–9:25 a.m.—C. H. Butler

Presentation of speakers, discussion of objective, discussion of registration, and housing.

Lecture 10, The Analysis of Variance—9:30–10:50 a.m.—Fred Beeler (Ch. X, Sect. 1, 2)

Object. The idea that variability is quantitative and hence may be subdivided is developed very fully.

Contents. (a) The analysis of variance within and among groups is illustrated by that within and among reels, as in a multiple-reel cutting operation. (b) The analysis of variance is further illustrated by the case of basis weight in and across a machine direction. The essentially different nature of these two variances is stressed and shown.

Laboratory VIII, The Test of Significance in Analysis of Variance—11:00 a.m.–1:00 p.m.

One example of testing the significance of an analysis of variance, for data as previously, is given. There is heavy emphasis on the routine of statistical procedure.

Informal Laboratory A—2:30–5:00 p.m.

It is suggested that there be organized a laboratory strictly concerned with the simple details of operating a calculating machine. Besides the fundamental operations of adding through division, there could be discussed the operation of extracting a square root and the idea and advantages of continuous operation (with a minimization of writing before an answer is obtained).

Informal Laboratory B—2:30–5:00 p.m.

It is suggested that there be a laboratory concerned with the calculation of standard deviation by the methods both of range and of sums of squares.

Talk V—7:00–9:00 p.m. (To be arranged)

Tuesday, June 23, 1953

Lecture 11, Application of Control Charts When There Is More Than One Kind of Variability—9:00–9:55 a.m.—C. A. Bicking (Ch. X, Sect. 3, 4)

Object. The essentially different nature of variance, as in and across paper machine direction, touched upon in Lecture 10 is here developed and its implications in the application of routine quality control are brought out.

Contents. There is discussed the use of X bar and *R* charts for process control in problems where there is variability in and across a paper machine. The choice of rational subgroups and the problem of varying sample size are considered.

Laboratory IX, The Analysis of Variability in and Across a Machine—10:00–11:50 a.m.

Two examples of the analysis of variability of production are studied. There is heavy emphasis on the routine of statistical procedure.

Lecture 12, The Partition of Variance—12:00 a.m.–1:00 p.m.—Geoffrey Beall (Ch. X, Sect. 6)

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Object. It is necessary to point out emphatically and clearly that in production more is required than to test the statistical significance of an element of variability. It must be shown how much it contributes to the over-all variability. Contrariwise, it must be discovered how much real good would be done to an operation by elimination of a given source of variability.

Contents. The material of Lectures 10 and 11 is reconsidered from the point of view of the partition of variance, i.e., the various contributions of variability in and across the machine and the remaining variability are assayed with regard to their contribution to total variability per item. This question is very treacherous because the contribution of variability in or across may be very small compared to the remaining, nonsystematic variability. It is thus possible to judge the reduction in general variability possible by, say, control in the machine direction.

Informal Laboratory A—2:30–5:00 p.m.

A laboratory on machine operation, as for the previous day, is suggested.

Informal Laboratory B—2:30–5:00 p.m.

It is suggested there be a laboratory concerned with process control, $\bar{X}$ and R, for quantitative characters of paper. This session would be designed as a brush-up for those participants who had not attended the first week of the conference.

Talk VI—7:00–9:00 p.m. (To be arranged)

Wednesday, June 24, 1953

Lecture 13, Two-Way Analysis of Variance as an Experimental Tool—9:00–9:55 a.m.—C. A. Bicking

Object. The present lecture is aimed at completing the picture of analysis of variance as previously presented during the week. They were essentially concerned with an investigation of variability as it may exist in production. The present lecture is concerned with variability as it may be introduced by changes in mill or laboratory procedure. Then the problem becomes one of deciding on the importance of the changes in procedure as judged by variation in the result. We become involved in tests of significance.

Contents. The analysis of variance is completed by the calculation of the critical ratio F. The tables of significance levels for F are presented and discussed. The practical implications of the test are stressed. A possible confusion between statistical significance and practical importance is touched upon.

Lecture 14, The Anticipation of One Measured Character from Another (Regression)—10:00–10:50 a.m.—Geoffrey Beall (Ch. XI, Sect. 1, 2, 3)

Object. A new field of investigation is opened with this lecture, viz., the correspondence of two sets of continuous variables. The question considered at once is how one may be anticipated from the other.

Contents. Illustrations of strength of corrugated board as predictable from tests on the liners and corrugating medium are presented in illustration of a regression. The method of least squares fitting is developed as a technique, but not the logic. The fact that for any body of data there are two regressions is taken up. The dangers inherent in calibration operations are stressed. The possibility of simplifying the calculation of a regression when the independent variable is regularly spaced is pointed out.

Laboratory X, The Calculation of Regression—11:00 a.m.–1:00 p.m.

1. A simple example of regression on the type of problem of lecture is worked.
2. A similar problem in establishing the conversion of readings from a new Mullen tester to an old one is worked. The conversion of readings from the old to the new is also worked to illustrate the danger of using a regression inversely.

Informal Laboratory A—2:30–5:00 p.m.

A laboratory on the analysis of variance is suggested.

Informal Laboratory B—2:30–5:00 p.m.

A laboratory on the calculation of regression is suggested.

Talk VII—7:00–9:00 p.m. (To be arranged)

Thursday, June 25, 1953

Lecture 15, Variability of a Regression—9:00–5:55 a.m.—C. A. Bicking (Ch. XI, Sect. 4, 5, 6)

Object. The regression can be calculated for a given body of data with complete finality which may be deceptive because repetition of the work will yield somewhat different results. Our business is to anticipate the degree of such differences.

Contents. Illustrated material is shown of the various regressions that may be calculated from small subdivisions of data. The point is made that caution should be observed. The standard deviation of the slope is presented and its confidence limits are found.

Laboratory XI, The Calculation of Confidence Limits of a Regression—10:00–11:55 a.m.

A simple case of material of the kind discussed is treated to find the confidence limits of its slope.

Lecture 16, The Correlation, as of Strength Characters—12:00 noon–1:00 p.m.—Fred Beeler (Ch. XI, Sect. 7, 8)

Object. The correlation is presented as a quantity related to the regression but the element of relationship is reduced to a pure dimensionless number.

Contents. There is considered as illustrative material, strength characters of corrugated board. The correlation coefficient is considered from the viewpoint of the definition $r^2 = (\sigma_y^2 - S_y^2)/\sigma_y^2$. Here σ_y is the standard deviation of some observations y, and S_y is the variability of the same observations about a regression line.

Informal Laboratory A—2:30–5:00 p.m.

A laboratory on the calculation of correlation is suggested.

Talk VIII—7:00–9:00 p.m. (To be arranged)

Friday, June 26, 1953

Lecture 17, The Correlation of Strength Characters (continued)—9:00–9:55 a.m.—Fred Beeler

Object. The meaning and utility of the correlation coefficient are further developed.

Contents. From the definition of the correlation it follows that the variability residual about a regression, $S_y^2 = (1 - r^2)\sigma_y^2$ and hence we have a measure of the reliability of regression predictions. The dangers of confusing correlation with causality are also treated.

Lecture 18, The Chance Variability of a Correlation—10:00–10:50 a.m.—Geoffrey Beall

Object. The concept of the correlation coefficient is rounded out by a discussion of its chance fluctuation and limitations.

Contents. Using the same material as for Lecture 17, the variability of correlations is illustrated. The dangers of standard theory or variability of a correlation, in contrast to the safeness of that for the slopes of a regression are developed. With this reservation the chance variability of a correlation is found by use of the table of z.

Laboratory XII, The Calculation of Correlations—11:00 a.m.–1:00 p.m.

Two simple illustrative bodies of data are considered and their correlations calculated.

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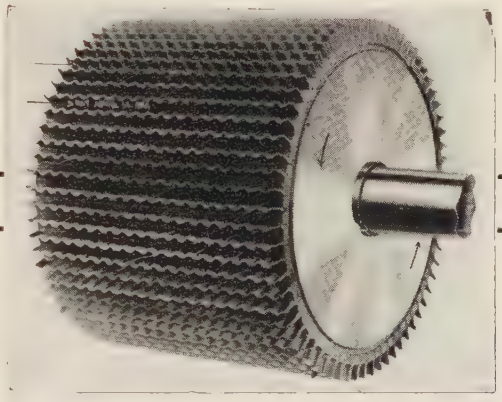

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New TAPPI Members

Stanton Allen, Management Consultant, Milwaukee, Wis., a 1942 graduate of the University of Michigan.

Sergio J. M. Antunes, Technical Supervisor, Cia. Industrial de Papel Pirahy, Rio de Janeiro, Brazil, a 1946 graduate of MacKenzie College.

Kenneth L. Arndt, Technical Director, Peavey Paper Mills, Inc., Ladysmith, Wis. Attended Superior State College.

Adalberto T. Arroyava, Chemical Engineer, Fabricas de Papel Loreto y Pena Pobre, S. A., a 1940 graduate of the University of Mexico.

Robert W. Birch, Junior Engineer, Union Bag & Paper Corp., Savannah, Ga., a 1952 graduate of Carnegie Institute of Technology.

James M. Booth, Paper Trade Journal, New York, N. Y., a 1924 graduate of Lowell Textile Institute.

Russell S. Bracewell, Plant Manager, Kupfer Bros. Co., Northbridge, Mass., a 1916 graduate of the University of Kansas.

Richard K. Britton, Chemical Engineer, Roy S. Sanford & Co., Oakville, Conn., a 1935 graduate of the University of Cincinnati, and a 1939 graduate of Carnegie Institute of Technology.

Paul C. Brown, Assistant Vice-President, Tileston & Hollingsworth Co., Boston, Mass., a 1936 graduate of the University of Maine.

Thomas M. Burton, Associate, Chas. T. Main, Inc., Boston, Mass., a 1934 graduate of Massachusetts Institute of Technology.

Dwayne J. Clark, Chemist, Everett Pulp & Paper Co., Everett, Wash., a 1941 graduate of the University of Washington.

Robert E. Crockett, Assistant Manager, International Paper Co., Niagara Falls, N. Y., a 1934 graduate of the University of Maine.

Norman L. Danforth, Superintendent, Electrical and Instrument Depts., St. Regis Paper Co., Bucksport, Me.

Clyde Davis, Jr., Control Superintendent, Finch, Pruyn & Co., Inc., Glens Falls, N. Y.

Isaac R. Dunlap, Chemist, Industrial Tape Corp., New Brunswick, N. J., a 1936 graduate of Ohio State University.

George C. Eastin, Jr., Technical Director, Escanaba Paper Co., Escanaba, Mich., a 1943 graduate of Purdue University.

Judson D. Elston, Manager, Research Laboratory, General Box Co., DesPlaines, Ill., a 1946 graduate of Yale University.

Carl M. Farnham, General Manager, Everett Paper Mills, Inc., Marcellus Falls, N. Y., a 1923 graduate of New York State College of Forestry.

Norman G. Fisher, Assistant Head, Intelligence Div., E. I. du Pont de Nemours & Co., Wilmington, Del., a 1930 graduate of the University of Akron, with a Ph.D. degree from the University of Wisconsin in 1934.

Cecil S. Flenniken, Paper Mill Engineer, International Paper Co., Springhill, La., a 1949 graduate of Georgia Institute of Technology.

Alroy E. Frankfurter, Project Engineer, Sandwell & Co., Seattle, Wash., a 1940 graduate of the University of Washington.

Warren A. Girard, Production Manager, Peavey Paper Mills, Inc., Ladysmith, Wis.

Maurice K. Goddard, Head, Dept. of Forestry, The Pennsylvania State College, State College, Pa., a 1935 graduate of the University of Maine.

Harry Goldsmith, Assistant Plant Manager, Industrial Container Corp., Brooklyn, N. Y. Attended Pratt Institute.

Germaine Gomez, Chemist, Champion Paper & Fibre Co., Pasadena, Tex., a 1949 graduate of Southwestern Louisiana Institute.

Victor M. Granada, Graduate Student, Pulp and Paper Dept., New York State College of Forestry, Syracuse, N. Y., a 1950 graduate of the University of Idaho.

Nella S. Gruenhut, Senior Chemist, Stein, Hall & Co., Inc., New York, N. Y., a 1937 graduate of the University of Vienna with a Ph.D. degree.

Kenneth W. Grundy, Paper Technician, The Clayton Aniline Co. Ltd., Clayton, Manchester, England.

Sven-Erik Hagglund, Chemical Engineer, Swedish Forest Products Research Laboratory, Stockholm, Sweden, a 1947 graduate of the Royal University of Technology.

Ernest E. Hoffman, Jr., Technical Salesman, Continental Turpentine & Rosin Corp., Laurel, Miss., a 1940 graduate of Mississippi State College.

John F. Hooper, Chief Chemist, Rayonier, Inc., Jesup, Ga., a 1938 graduate of the University of Maine, and a 1940 graduate of Washington State College.

John R. Hopkins, Technical Sales Representative, Becco Sales Corp., Buffalo, N. Y. Attended Princeton University.

Annette Horne, Technician, Herty Foundation Laboratory, Savannah, Ga. Attended Wesleyan College.

R. Joseph Houle, Supervisor, Packaging Section, Lever Bros. Co., Edgewater, N. J., a 1930 graduate of Bates College.

Stanley J. Johnson, Research Chemist, S. D. Warren Co., Cumberland Mills, Me., a 1922 graduate of the University of Maine.

Louis E. Kelley, Head, Paper Research Laboratory, Rohm & Haas Co., Philadelphia, Pa., a 1938 graduate of Williams College.

Peter A. Kimen, Process Engineer, Champion Paper & Fibre Co., Pasadena, Tex., a 1937 graduate of Kansas State College.

Maseo Kubota, Director, Asahi Chemical Industry Co., Ltd., Miyazaki-ken, Japan, a 1931 graduate of Tokyo University.

Walter G. Kunze, Chief Chemist, Le Page's, Inc., Goucester, Mass., a 1933 graduate of Technical University, Darmstadt, Germany, with a Dr. of Engineering degree.

George W. Legg, Chief of Chemist, Cellulose Development Corp. Ltd., Hatch End, Middlesex, England. Attended Wollwich Polytechnic College.

Erhard Liebert, Director of Research and Development, Munchen Dachauer Papierfabriken Heinrich Nicolaus G.m.b.H., Dachau, West Germany, a 1933 graduate of Darmstadt College, with a Dr. of Engineering degree in 1940.

Gunnar L. D. Lindstrom, Chief Engineer, Hellefors Bruks A.B., Hellefors, Sweden. Attended the Technical University, Stockholm.

Edwin R. Littmann, Market Development, Enjay Co., Inc., Elizabeth, N. J., a 1929 graduate of the University of Illinois.

Donald G. Luebke, Supervisor, Materials Handling Methods, Marathon Corp., Menasha, Wis., a 1946 graduate of the University of Minnesota.

Ronald G. Macdonald, Maintenance Superintendent, Ecusta

Paper Corp., Pisgah Forest, N. C., a 1932 graduate of Tufts College.

John P. Matukas, Laboratory Technician, Crocker, Burbank & Co., Fitchburg, Mass.

Russell I. McCabe, General Manager and Secretary, Sherbrooke Machineries Ltd., Sherbrooke, P. Q., Canada, a 1930 graduate of McGill University.

Sam C. McKee, Student, Institute of Paper Chemistry, Appleton, Wis., a 1951 graduate of the University of Washington.

LeRoy A. Mortenson, Sales Engineer, Turbine Equipment Co., New York, N. Y. Attended New York University.

John T. Moynihan, Paper Technologist, National Bureau of Standards, Washington, D. C., a 1949 graduate of the University of Massachusetts.

Millard M. Muntz, Chemist, P. H. Glatfelter Co., Spring Grove, Pa., a 1950 graduate of Gettysburg College.

Hideo Nakura, Chief, Paper Making Section, Daishowa Paper Mfg. Co. Ltd., Fuji-gun, Shizuoka Pref., Japan, a 1934 graduate of Kiryu Technical College.

Per Paren, Chief Engineer, Steam Boiler Dept., Jonkopings Mekaniska Werkstads A.B., Jonkoping, Sweden, a 1937 graduate of Royal Technical University.

Mary Parsons, U. S. Information Center Library, American Embassy, Paris, France.

James A. Pettigrew, Engineer, Potlatch Forests, Inc., Lewiston, Idaho, a 1934 graduate of Duke University.

Bernard S. Reckseit, Plant Engineer, The Nivison-Weiskopf Co., Reading, Ohio, a 1947 graduate of Massachusetts Institute of Technology.

Kazuo Sawada, Acting Chief, Research Dept., Sumitomo Chemical Co., Osaka, Japan, a 1935 graduate of Osaka University.

Enrique Schcolnik, President, Schcolnik Soc. Anon. Industral y Commercial, Buenos Aires, Argentina, 1940 graduate of Buenos Aires University.

Raymond B. Seymour, Executive Vice-President and Technical Director, The Atlas Mineral Products Co., Mertztown, Pa., a 1933 graduate of the University of New Hampshire with a Ph.D. degree from the State University of Iowa in 1937.

John M. Shedd, Chief Chemist, Everett Pulp & Paper Co., Div. Simpson Logging Co., Everett, Wash., a 1915 graduate of the University of Vermont.

William R. Shook, Jr., District Manager, Electric Machinery Mfg. Co., Decatur, Ga., a 1939 graduate of Georgia Institute of Technology.

Earland K. Sleight, Assistant Chemist, Penobscot Chemical Fibre Co., Great Works, Me., a 1943 graduate of the University of Maine.

Martin H. Smith, Techical Service Representative, Atlas Mineral Products Co., Mertztown, Pa., a 1948 graduate of Columbia University.

Warren T. Stege, Special Engineer, American Box Board Co., Filer City, Mich., a 1949 graduate of Michigan State College.

John M. Steiner, Sales Engineer, John W. Bolton & Son, Lawrence, Mass.

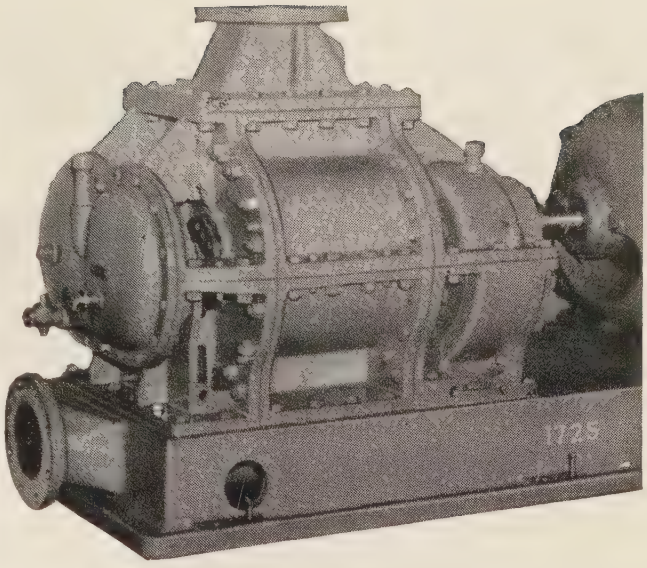
Harold R. Stoakes, Editor, *American Paper Converter*, Chicago, Ill. Attended the University of Minnesota.

Richard L. Stork, Technical Sales Representative, Reichhold Chemicals, Inc., Detroit, Mich., a 1949 graduate of Tri-State College of Engineering.

Johannes C. Ulrich, Research Chemist, Papierfabrik Biberist, Biberist, Switzerland, a 1941 graduate of Polytechnic Federal College with a D.Sc. degree in 1945.

Vincent H. Urquhart, Plant Manager, Seaboard Container Corp., Bristol, Pa.

Albert L. Van Stappen, Supervisor, Product Improvement Group, E. I. du Pont de Nemours & Co., Inc., Rochester, N. Y., a 1934 graduate of the University of Ghent with a Dr. of Chemistry degree.



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Clifford J. Wahl, Vice-President, The Gebhart Folding Box Co., Dayton, Ohio. Attended the University of Cincinnati.

Jack W. Wilson, Assistant Professor, University of British Columbia, Vancouver, B. C., Canada, a 1948 graduate of the New York State College of Forestry with a Ph.D. degree in 1950.

TAPPI Notes

Cecil H. Baldwin, Technical Director of the Marinette Paper Co., has been transferred from Marinette, Wis.

LeRoy J. Bauer, formerly with Chas. T. Main, Inc., is now Chief Plants Engineer for Doeskin Products, Inc., Mt. Tom, Mass., Wheelwright, Mass., and Rockland, Del.

R. William Brown, formerly Plant Engineer for the St. Regis Paper Co., Howland, Me., is now located at the Nashua River Div. at East Pepperell, Mass.

Edward L. Cowan, formerly of the Gaylord Container Corp., is now Chief Engineer of Bowater's Southern Paper Corp., Calhoun, Tenn.

Alvaro de la Macorra, formerly Trainee at the Union Bag & Paper Corp., is now Chemical Engineer for the San Rafael Paper Co., Mexico, D. F., Mexico.

Victor A. Denslow is now Manager of Wax Sales for Cities Service Oil Co., Chicago, Ill.

Joseph J. Fiori is now Vice-President in Charge of Paper Mills for Stone Container Corp., Franklin, Ohio.

Rowland A. Gale, formerly of Pillsbury Mills, Inc., is now Manager of Gale Chemical Products, Yonkers, N. Y.

Leif Grogaard, Technical Director of A/S Union has transferred from Skien to Oslo, Norway.

Silas L. Guttridge, Supervisor of Manufacture of Fiber Containers of the American Can Co., has been transferred from San Francisco to Los Angeles, Calif.

Shu-Tang Han, formerly Engineer for the National Government of China, is now a Technical Associate at The Institute of Paper Chemistry, Appleton, Wis.

Paul W. Hardesty of the Mead Corp. has been transferred from the Wheelwright Div., Leominster, Mass., to the Heald Div., Lynchburg, Va.

Joseph E. Hartford is now Assistant General Manager of the Black-Clawson Co., Hamilton, Ohio.

Fred Herbolzheimer, Jr., formerly of the Scott Paper Co., is now Technical Director of the Marinette Paper Co., Marinette, Wis.

Ernest R. Hess, formerly of the Gary Paper Mills, Inc., is now Chemical Engineer for the Kleistone Rubber Co., Warren, R. I.

Gordon I. Hoover is now Manager of the Thorold, Ont., mill of Provincial Paper, Ltd.

Nicholas A. Jappe, formerly of the Coos Bay Pulp Corp., is now Student at The Institute of Paper Chemistry, Appleton, Wis.

Tony Jurecic, formerly Student at the University of North Carolina, is now a Trainee at the North Carolina Pulp Co., Plymouth, N. C.

Robert L. Knickerbocker, formerly of the Mohawk Paper Mills, Inc., is now a Sales Representative for Asten-Hill Mfg. Co., Philadelphia, Pa.

R. L. Kutter is now Vice-President and General Manager of the Black-Clawson Co., Hamilton, Ohio.

Arthur H. Lambert has been discharged from the U. S. Army and has returned to the New York State College of Forestry, Syracuse, N. Y., as a student.

Robert J. Lurvey, formerly of the Johns-Manville Corp., is now a Chemical Engineer for the H. & V. Specialties Co., West Groton, Mass.

James M. McCrum, formerly of the Australian Paper Mfgrs. Ltd., is now Production Manager of the Tasmanian Board Mills, Ltd., Launceton, Tasmania.

Winslow B. Mills of the St. Regis Paper Co. is now General Superintendent of the St. Regis Paper Co., Kraft Div. (Black

River District) and the Polyethylene Coating Div., Carthage, N. Y.

Walter B. Morehouse is now Assistant Vice-President, Nopco Chemical Co., Harrison, N. J.

Jaakko O. Murto, formerly with Keskuslaboratorio Oy, is now with Metex Cooperative Group, Helsinki, Finland.

George O. Nelson, formerly Technical Director of Coos Bay Pulp Corp., is now with the Puget Sound Pulp & Timber Co., Bellingham, Wash.

Gunnar W. E. Nicholson is now Executive Vice-President of the Union Bag & Paper Corp., New York, N. Y.

Edward H. Niederauer, formerly of the Escanaba Paper Co., is now Production Manager of the Kingsport, Tenn., Div. of the Mead Corp.

Carl P. Olstad, formerly of the Waxide Paper Co., is now Manager of Production Development for the Johnson Foil Mfg. Co., St. Louis, Mo.

Leonard A. Pierce of the St. Regis Paper Co. has transferred from Holland, Me., to Kalamazoo, Mich., as Assistant Resident Manager.

Samuel J. Quattrocchi, formerly of the Deerfield Glassine Co., is now General Superintendent of the Pennsylvania mills of the Westfield River Paper Co., West Conshohocken, Pa.

Lynn E. Rolig, formerly of the Ohio Boxboard Co., is now Development Engineer for the Ex-Cello Corp., Pure-Pak Div., Detroit, Mich.

Carl E. Schmitz is now Vice-President in Charge of Sales of the Crane Packing Co., Chicago, Ill.

Milton O. Schur is now Manager of Research and Development for the Ecusta Paper Corp., Pisgah Forest, N. C.

George R. Shaw is now Supervisor of the Vulcanized Fibre and Paper Mills of the Taylor Fibre Co., Betzwood, Pa.

David B. Snedeker, formerly of the American Cyanamid Co., is now Consulting Chemist for Wm. A Reed & Co., Inc., Lyons, Ill.

Harry M. Spring, Jr., formerly of the Mutual Boiler & Machinery Insurance Co., is now Consultant, 280 Pleasant St., Boston, Mass.

I. J. Stafford is now Vice-President in Charge of Manufacturing for the Neenah Paper Co., Neenah, Wis.

R. H. Stevens, formerly Technical Director of the National Container Co., has retired and is living at 6655 Sunset Drive, Jacksonville, Fla.

Louis T. Stevenson, Economist for the American Paper and Pulp Association, has retired and is engaged in economics counselling in New York, N. Y.

Wesley N. Stickel is now Director of Research for Texon, Inc., South Hadley Falls and Russell, Mass.

Peter Van Wyck is now Experiment Station Director of the Hercules Powder Co., Wilmington, Del.

John E. Webb, Engineer for the Sonoco Products Co., has transferred from Mexico, D. F., Mexico, to Hartsville, S. C.

Samuel T. Weber is now Sales Manager of Black-Clawson Co., Hamilton, Ohio.

Francis O. Whipple, formerly Student at Oregon State College, is now with the Crown Zellerbach Corp., Camas, Wash.

Alvin R. Wilson, formerly Chemist for the Wynmoor Mfg. Co., is now with the Hamilton Mfg. Co., Inc., Richmond, Va.

James A. Wise is now President of the Kalamazoo Paper Co., Kalamazoo, Mich.

Steve H. Wise has been discharged from the U. S. Army and has returned to the Wood Conversion Co., Cloquet, Minn., as a Junior Technologist.

Jack Fife Wright is now Assistant Manager, General Office Paper Div., National Aniline Div., Allied Chemical & Dye Corp., Boston, Mass.

Carl J. Wynstra, formerly of the Container Corp. of America, is now Chief Chemist for the Central Fibre Products Co., Quincy, Ill.

John Zima is now Secretary of the News Print Service Bureau, New York, N. Y.

William R. Zwecker, formerly of the Chippewa Products

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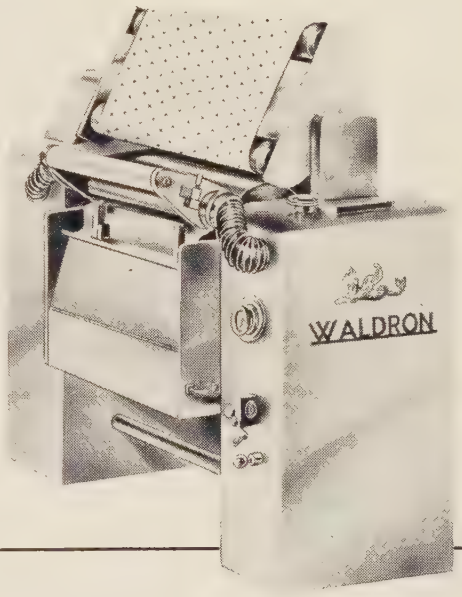

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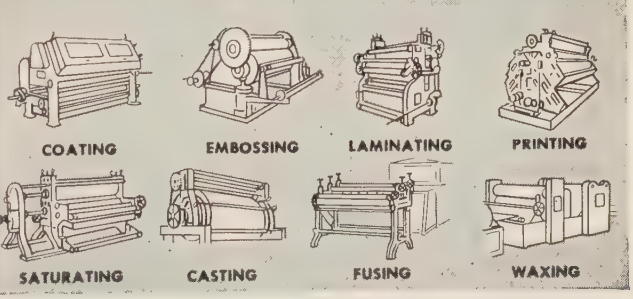

Co., is now Director of Research & Special Products Development for the Inland Wallpaper Co., Chicago, Ill.

* * *

George A. Zinkel has succeeded *Howard M. Blandin* as official corporate representative of the Central Fibre Products Co., Quincy, Ill., in the Technical Association.

Merritt-Chapman & Scott Corp., a TAPPI sustaining member, has removed its New York headquarters from 17 Battery Park to 260 Madison Ave.

E. H. Wagner, Manager of Industrial Sales has succeeded *W. S. Carneille* as the official representative of SKF Industries, Inc., Philadelphia, Pa., in TAPPI.

J. S. Detwiler, Divisional Sales Manager, has succeeded *A. C. Mahana* as the official representative of Taylor Instrument Cos., Rochester, N. Y., in TAPPI.

Industry Notes

Production (Preliminary Report)

Paper and board production totaled 24,413,212 tons and wood pulp production amounted to 16,466,810 tons in 1952, according to a preliminary report issued by the Bureau of the Census, Department of Commerce, Paper and board produc-

Table I. United States Production of Wood Pulp and Consumption of Wood Pulp, Pulpwood and Other Fibrous Materials in the Manufacture of Paper and Board, by Kinds, 1952, 1951, and 1950

	Production			Consumption		
	1952 preliminary	*1951*[a]	*1950*[a]	*1952 preliminary*	*1951*[a]	*1950*[a]
	Tons of 2000 Lb.					
Wood Pulp, Total	16,466,810	16,524,408	14,848,951	17,273,682	17,736,970	16,508,905
Special alpha and dissolving grades	706,033	616,202	478,849	71,362[b]	52,257[b]	39,846[b]
Bleached sulphite	1,691,523	1,760,685	1,628,692	1,943,624	2,036,800	2,029,399
Unbleached sulphite	675,212	764,640	740,895	1,027,176	1,203,487	1,246,876
Bleached sulphate	2,082,844	1,899,014	1,432,945	2,495,308	2,382,682	1,861,597
Semibleached sulphate	275,062	293,584	359,917	307,543	330,133	389,436
Unbleached sulphate	6,210,798	6,379,172	5,708,567	6,328,350	6,596,611	6,129,791
Soda	425,415	446,260	522,221	463,478	484,337	559,143
Groundwood	2,379,740	2,473,796	2,215,883	2,608,318	2,751,659	2,482,732
Semichemical	821,153	796,546	685,906	820,359	796,819	685,461
Defibrated or exploded	1,059,124	944,776	934,666	1,063,944	943,657	931,944
Screenings, damaged, etc.	139,906	149,733	140,410	144,229	158,528	152,680
Other Fibrous Materials, Total	...	...	...	9,079,954	10,513,576	9,395,374
Waste paper	...	...	...	7,881,035	9,070,554	7,956,036
Straw	...	...	...	315,872	402,276	405,618
Rags	...	...	...	324,560	387,843	441,894
Cotton fiber	...	...	...	14,044	16,969	21,286
Manila stock	..	...	...	38,272	44,541	39,883
All other	...	...	...	506,171	591,393	530,657
	Cords of 128 Cu. Ft.—Roughwood Basis					
Pulpwood, Total	...	...	...	26,462,219	26,521,795	23,627,217
Softwood	...	...	...	22,662,381	22,768,368	20,405,910
Hardwood	...	...	...	3,799,838	3,753,427	3,221,307

[a] Revised.
[b] Wood pulp consumption reported by plants classified outside paper and board industries amounted to 753,978 tons in 1952, of which alpha and dissolving grades amounted to 675,452 tons. Comparable data for 1951 amounted to 713,840 tons, of which 671,974 tons were alpha and dissolving grades. Comparable data are not available for the year 1950.
Source: Data represent a summation of the monthly Facts for Industry reports (Series M14A) for the industry, revised to include late and corrected reports received subsequent to the publication of the monthly releases.

Table II. Paper and Board Production in the United States: 1952, 1951, and 1950

	1952 preliminary	*1951*	*1950*
All Types, Total	24,413,212	26,048,143	24,375,083
Paper, total	10,895,800	11,624,727	10,638,797
Newsprint	1,106,351	1,108,165	1,013,346
Groundwood paper	808,812	790,621	705,329
Paper machine-coated	1,096,251	1,112,990	1,020,002
Book paper	1,482,488	1,610,450	1,578,795
Fine paper	1,295,179	1,366,425	1,197,309
Coarse paper (including shipping sack)	3,235,021	3,627,072	3,298,457
Special industrial paper	396,251	408,381	341,230
Sanitary tissue	1,148,467	1,243,858	1,148,351
Tissue paper (except sanitary and thin)	209,181	229,174	216,865
Absorbent paper	117,799	127,591	119,113
Paperboard, total	10,776,452	11,620,048	10,925,232
Liners	3,904,796	4,213,328	3,872,051
Corrugating material	1,583,472	1,784,163	1,633,575
Container chip and filler board	282,044	325,291	324,651
Folding boxboard	2,193,986	2,362,356	2,351,955
Special food board	796,994	772,541	654,748
Other bending board	154,328	136,682	124,435
Setup boxboard	687,078	733,475	711,805
Other nonbending board	95,546	143,317	164,471
Special paperboard stock	1,008,801	1,063,597	1,000,793
Cardboard	69,407	85,298	86,748
Wet-machine board	137,205	148,381	166,237
Construction paper and board, total	2,603,755	2,654,987	2,644,817
Building paper and insulation	1,298,300	1,385,691	1,425,249
Hardboard	425,081	343,552	381,201
Insulating board	880,374	925,744	838,367

Source: Data for 1952 represent a summation of the monthly Facts for Industry releases (Series M14A) revised to include late and corrected reports. Data for 1951 and 1950 are from Facts for Industry Series M14F-01Paper, and Board Production: 1951."

ion has decreased 6% from the all-time high level of 26,048,-143 tons produced in 1951, whereas wood pulp production remained at the high 1951 level. (See reverse for detailed statistics.)

Paper production totaled 10,895,800 tons, a 6% decrease from the record 1951 output. Production reflected decreases in all major grades except groundwood paper which showed a slight increase over 1951.

Paperboard output in 1952 amounted to 10,776,452 tons, 7% less than reported for 1951. Decreases from the high 1951 output are consistent in every major grade except special food board and other bending board which show an upward trend in 1950, 1951, and 1952.

There were slight decreases from the 1951 output shown in most major grades of wood pulp. The following gains in four major grades resulted in total production remaining at the high 1951 level: special alpha and dissolving grades, 15%; bleached sulphate, 10%; semichemical, 3%; defibrated or exploded, 12%.

The consumption of wood pulp and fibrous materials other than wood pulp in the manufacture of paper and board amounted to 17,273,682 tons and 9,079,954 tons, a decrease of about 3 and 14%, respectively. The consumption of pulpwood amounted to 26,462,219 cords, measured on a rough wood basis, continuing at the high 1951 level.

Wood Pulp Imports

The total imports of wood pulp in 1952 amounted to 1,936,652 tons. The imports from Canada comprised 81% (1,577,514 tons) and imports from Europe were 19% (359,138 tons) of the total. The total imports in 1952 were 18% less than in 1951. With regard to individual grades of pulp, the sharpest decrease was in unbleached sulphate, down 38%. The only grade of pulp showing an increase in import volume was bleached groundwood which amounted to 34,000 tons, as compared with 17,000 tons in 1951.

The imports, according to country of origin were as follows: Canada—1,577,514; Sweden—189,613; Norway—21,168; Germany—169; France—124; and Austria 2430 short tons.

Wastepaper

Approximately 7,500,000 tons of wastepaper were consumed in 1952 by the paperboard, paper, and building materials industries. An additional tonnage, of unestimated size, was consumed for shredding and packing and quantities were sold for export to other countries. At the same time, a very large percentage of the watepaper generated in the United States was uncollected and the valuable fibers contained therein destroyed either by incineration or hauled to dumps and landfills.

One of the chief objectives of the Eastern Conservation Committee of the Wastepaper Consuming Industries is to stimulate the use of wastepaper. Wastepaper consumption in the past 20 years has more than doubled, and there has been built up in this country a great industry for its collection and processing for use by various classes of consumers.

About one in every three newspapers that were sold in the United States last year, after being read, were saved, collected, and sold for industrial purposes.

Consumption of newsprint last year amounted to 5,988,471 tons, according to the American Newspaper Publishers Associaton. That was an increase of 0.9% over 1951 and 0.2% over 1950. In other words, close to six million tons of newsprint paper are being consumed each year by the newspapers of the United States.

Approximately 2,250,000 tons of old newspapers were salvaged last year, of which almost 2,000,000 tons were consumed by paperboard and paper mills, and the remainder for export, wrapping of furniture, shredding, and packing for

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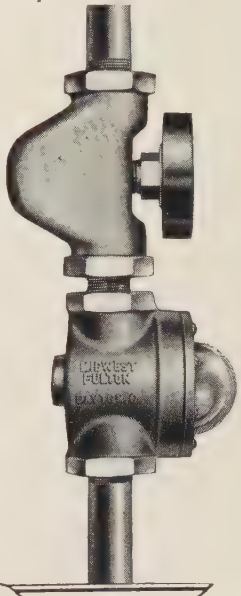

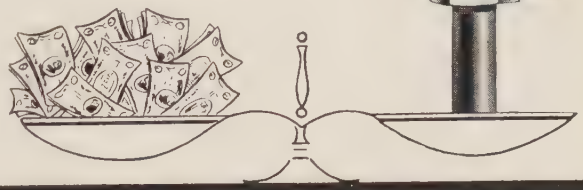

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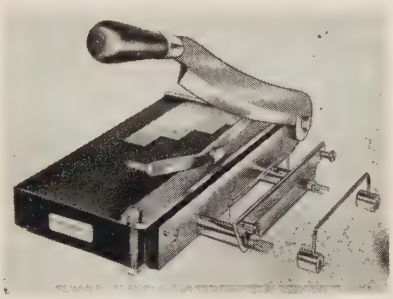

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industrial purposes. That left about 3,750,000 tons of old newspapers, uncollected, most of which were destroyed.

Perhaps one half of this large tonnage of uncollected newspapers could be salvaged without too much difficulty if new uses were discovered for the valuable fibers from which newsprint is made. The wastepaper industry throughout the country has been highly developed since the war, and, if called upon to do so, is capable of collecting much greater quantities of old newspapers than are required for present consumption.

In the studies and the experimentation that is going on in the development of new fibers and the finding of new uses for existing ones, consideration should be given to what may be obtained at a relatively low cost from the millions of old newspapers that, once printed and read, are immediately discarded. To annually produce the fibers from which newsprint is manufactured requires forest growth of many years on vast acreages as large perhaps as some of our states.

Greater quantities of wastepaper were consumed during the last year by the manufacturers of roofing materials, building paper, and building board than previously. The business of these industries held up well during 1952, and it may be expected that when the year's records are completed it will be seen that the production of building board in 1952 will have exceeded the 1,269,296-ton production of 1951. And the building paper production last year, it is now estimated, was very close to the production of 1,385,691 tons of 1951.

The increased use of wastepaper in these industries, say some of the consumers, has been due to the fact that the quality of the pack has been greatly improved during the past year. When the mills are able to obtain well-packed paperstock, free from junk and rubbish and containing none of the "glassy" papers, carbons, asphalt, tar, cement, wet-strength papers and plastics, say the buyers, they are quite willing to purchase it in preference in many instances to rags and pulp. Most of the packers recognize this fact, and, with adequate supplies available to meet all needs, they, like the mills, in many instances are becoming more selective as to the type and quality of the wastepaper they buy, and are insisting upon a better sorting job by their employees.

Marathon

Newly increased capacity of Marathon Corp.'s chemical plant at Rothschild is helping to clean up sulphite pollution of the Wisconsin River due to pulp and paper mill operations. The company announced recently that its Chemical Div. has just now begun operating new equipment which has boosted output of its sulphite liquor chemical by-products in powder form by 62.5%, and has increased its total by-products utilization of spent sulphite liquor by 25%. Marathon not only is using up all of its own sulphite liquor to make chemicals for sale, but actually is buying large quantities of concentrated liquor from another Wisconsin pulp manufacturer to provide raw material to supply its customers' needs.

More than a quarter century ago Marathon undertook a long-range research program to find ways to reduce sulphite pollution by developing processes for making use of the spent liquor so that this would not have to flow into the stream. In 1937 the company began using the processes which its staff of scientists had worked out for the commercial production of chemical products from this waste material, all of them derived from lignin, which is roughly one quarter of the total pulpwood. To date the company has invested $3,750,000 in chemical plant and research.

Applications of these products today range all the way from adhesives to vanillin for food flavoring. Lignin derivatives manufactured by Marathon in Wisconsin from spent sulphite liquor are now found in automobile batteries, leather, textile dyes and rubber, and are employed in operations as different as oil well drilling and treating boiler water.

None of the Rhinelander Paper Co.'s collected spent sulfite liquor is now going into the stream unprocessed, the company announced recently, exactly two months after starting up the first full-scale evaporator in the Wisconsin sulphite pulp industry.

'All of the liquor that we collect is being desugared in the torula yeast plant of Lake States Yeast Corp.," declared J. M. Holderby, who is vice-president of the yeast company and manager of Rhinelander Paper Co.'s by-products division. 'About three-quarters of the desugared liquor from the yeast plant is now being processed through our new evaporator plant.

'Of course our evaporator has not yet reached full operating capacity," Holderby continued. "Like any other brand new continuous process that uses new equipment, it still presents unexpected problems now and then. But our experience thus far has left us optimistic and we are gradually getting better efficiency.

'Burning the concentrated liquor under our boilers has worked out fully as well as we expected," Holderby conceded. "By now our combustion experience has left us reasonably sure that we know the technique of burning this fuel and have it down to a routine. But as yet we do not know the long-term effects upon equipment, such as possible corrosion of boiler plates and tubes."

Completion of the evaporator building has gone ahead steadily since the unit was turned on in mid-November. Heat insulation is ready to be applied to the equipment as soon as the engineers say there is no likelihood of further major modifications.

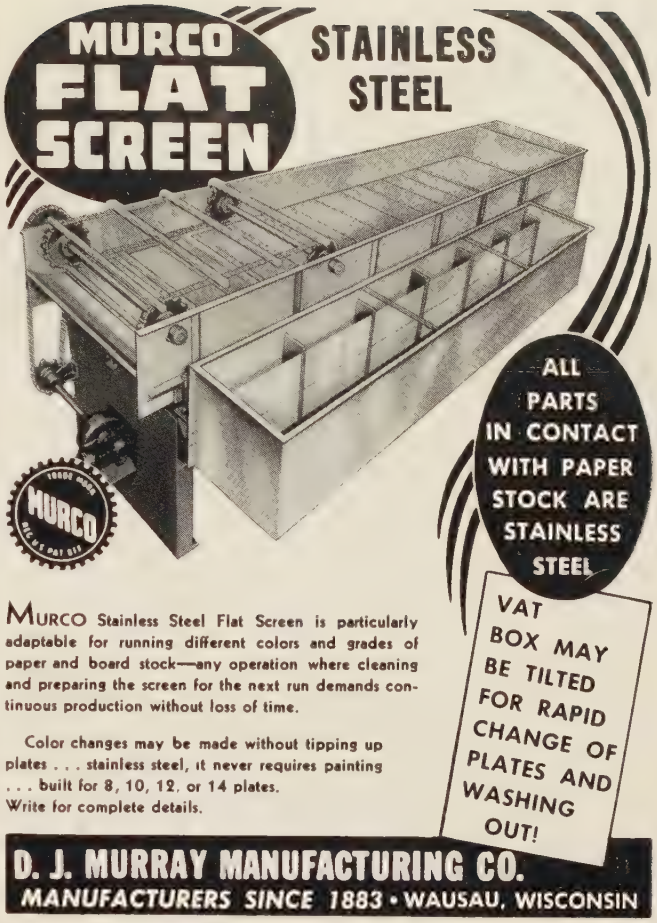
NEENAH PAPER CO.

At their annual meeting on January 26 the Board of Directors of the Neenah Paper Co., Neenah, Wis., announced the following new line-up of management executives: Leo O. Schubart, Executive Vice-President of the company since 1951 and a Director and Treasurer since 1928, has been elected President and General Manager.

D. K. Brown, the retiring President, was elected Chairman of the Board of Directors and is being retained for advice and consultation. I. J. Stafford, General Superintendent since 1923 and Director of Mill Operations since 1951, has been elected Vice-President for Manufacturing. Dan Hardt, Sales Manager since 1948 and a Director of the company since 1951, has been elected Vice-President for Sales. D. H. Severson, a Director of the company since 1948 and Treasurer since 1951, has been elected Secretary-Treasurer. Fred Leech has been appointed Sales Manager. He continues as a Director having been elected to the Board in 1952. These principals with Kimberly Stuart, former Vice-President, and Dr. Alan Adrian, Director of Research and Mill Operations, comprise the Board of Directors.

D. K. Brown, Neenah Paper Co.

L. O. Schubart Neenah Paper Co.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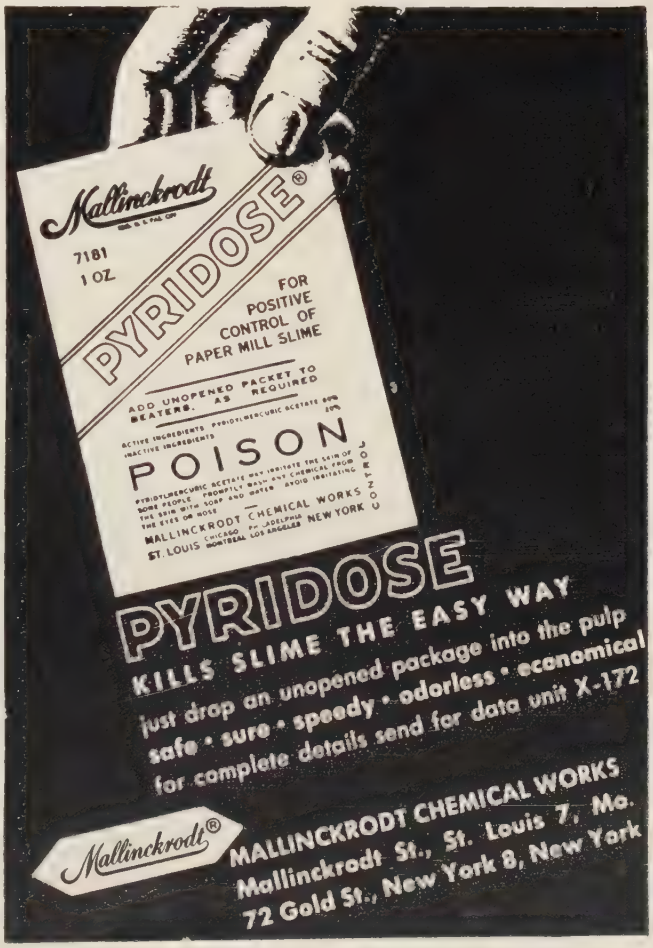
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D. H. Severson, Neenah Paper Co.

Mr. Brown's retirement from active management of the Neenah Paper Co. is the most recent event in a long and remarkable career of public service to the paper industry and the nation. His connection with the Neenah Paper Co. dated from Dec. 1, 1908. He has served as President of the Writing Paper Manufacturers Association, and for two years (1944 and 1945) was president of the American Paper and Pulp Association. He served during the last war on the overall Advisory Committee to the War Production Board for the pulp and paper industry, and is currently a member of the Advisory Committee to the National Production Authority, and of the Board of Governors of the National Stream Improvement Council. He was a founding Trustee of The Institute of Paper Chemistry at Lawrence College, Appleton, Wis., and has continued as a trustee ever since. He is also a member of the Executive and Finance Committee of The Institute of Paper Chemistry. He has been a Director of the First National Bank at Neenah, Wis., for over 20 years.

Mr. Schubart comes to the presidency of the Neenah Paper Co. after a continuous association with the company of 34 years. Mr. Stafford graduated from the Clarkson College of Technology in 1914 and before coming to the Neenah Paper Co. was employed by the U. S. Department of Commerce as a Supply Chemist; by the Dow Chemical Co. as a Research Chemist; by the Strathmore Paper Co. as Assistant Superintendent for two years, and by the American Writing Paper Co. as a Development Engineer for three years.

St. Regis at Jacksonville

St. Regis Paper Co. announces the commencement of production by its new kraft pulp, paper, and board mill at Jacksonville, Fla., having a capacity to produce 100,000 tons of paper annually. This addition raises the company's capacity for the production of kraft paper and board to 560,000 tons a year.

The new mill, located on a 200-acre site on tidewater at Eastport, on the outskirts of Jacksonville, is served by the Seaboard and Atlantic Coast Line railroads. In making the announcement, Roy K. Ferguson, President and Chairman of the company, states that the most modern manufacturing equipment has been installed, making full utilization of the company's experience gained in high volume production of kraft pulp, paper, and board in its Pensacola, Fla., and Tacoma, Wash., mills.

This mill, it is pointed out in the announcement, represents an important part of the long-range southern expansion program projected by the company that had as its aim complete integration of the Kraft Division, and in anticipation of which St. Regis acquired over the years a permanent source of wood supply in Florida, Alabama, Georgia, and Mississippi.

The announcement states that this new mill, capacity of which will be used principally for supplying kraft paper and board for the company's contract customers, has been planned, and key facilities installed in adequate size so that it can later be enlarged if long-term trends favor expansion.

The new mill is advantageously located in relation to pulpwood supply. The company owns or holds under long-term management contracts over 600,000 acres of timberlands in the south, of which approximately 300,000 acres are within a radius of 100 miles of Jacksonville. An adequate flow of wood will be available from these holdings and from farmers and other landowners within this area. On the basis of a capacity to produce 300 tons of kraft paper daily, the annual requirement of pulpwood for the mill is approximately 175,000 cords.

The fourdrinier paper machine at the Jacksonville mill, which was built and installed by the Beloit Iron Works, Beloit, Wis., has a wire 230 in. wide and 120 ft. long, and was designed for an ultimate speed of up to 2500 ft. a minute.

Many unique features, applied for the first time in paper mill construction, have been incorporated in the new company's newest facilities at Jacksonville, from the handling of wood through to the finishing room. Close to a million dollars has been spent for installation of the most modern developments in devices and equipment to eliminate or reduce to a minimum air pollution, odors, and stream pollution.

Merritt-Chapman & Scott Corp., New York, were general contractors on construction of the mill and also directed the work of all subcontractors. Stevenson and Rubens, Seattle, Wash., carried out the engineering work on the structural and architectural design, as well as the layout and process arrangements for the paper mill. Merritt-Chapman & Scott provided the structural and architectural design for the pulp mill and power plant, while Johnson & Co., New York, served as consulting engineers in furnishing the design for the pulp mill and power plant and also supplied the electrical engineering drawings for the whole mill.

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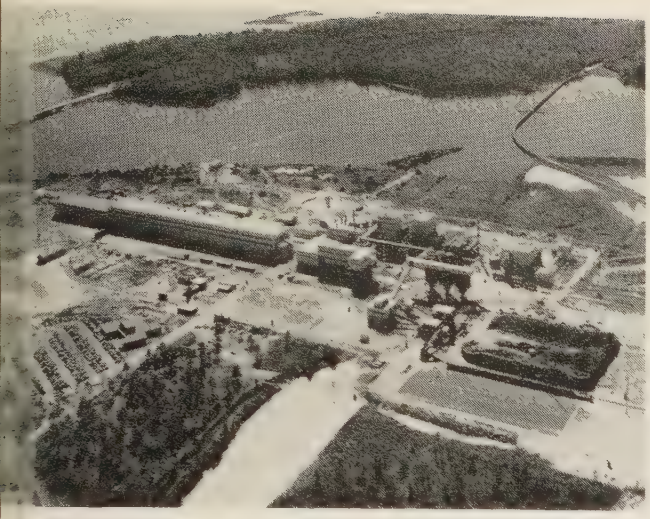

...r view of the new St. Regis kraft pulp, paper, and board ...ll at Jacksonville, Fla. This mill, with a capacity to ...oduce 100,000 tons of kraft paper annually, has just come into production

All phases of the project were under the executive direction of William R. Adams, St. Regis Vice-President and Director, while all design and construction were supervised and co-ordinated by Justin H. McCarthy, Chief Engineer of the Pulp and Paper Div. of the company.

John K. Ferguson, who was in charge of the company's lumber mill at Fargo, Ga., until construction of this mill started near the end of 1950, is resident manager at Jacksonville. John A. McDermott, who was transferred from the company's Tacoma, Wash., mill, is general superintendent. U. J. Westbrook is manager of production for the Southern Div., including pulp and paper manufacturing at both Pensacola and Jacksonville. Albert Ernest is Vice-President in Charge of Southern Timberlands and Procurement.

The major expansion of the company's kraft pulp, paper, and board capacity at its Pensacola, Fla., "Kraft Center" was completed in April, 1952, with the commencement of production by the No. 4 machine there capable of producing approximately 100,000 tons of kraft paper and board a year and raising the capacity there to 265,000 tons per annum of kraft paper and board.

Following is a detailed description of the facilities and equipment which makes this mill one of the most modern and efficient units in the industry.

Wood Handling

Pulpwood is stored on asphaltic concrete paving in piles 35 ft. high. There are two concrete, steel-lined flumes 500 ft. long and about 300 ft. apart extending into the woodyard area. This arrangement permits unloading from railroad rack type cars or trucks, either to storage, or directly to the flumes by means of two P & H crawler whirley cranes, with Owens pulpwood grapples furnished by Southern Corp. Two 16,000-g.p.m. Worthington circulating flume pumps are driven through V-belts by 100-hp motors, and are pit-located. Grit collectors and traveling water screens are provided to remove solids and bark from the flume water, which is reused. These are furnished by Link-Belt, as are all wood, bark, and chip conveyors in the mill.

Two barking drums, built by Fibre Making Process Co., are 12 ft. in diameter by 45 ft. long and are suspended by chains. Each drum is driven by a 150-hp., 720-r.p.m. motor. The bark removed from the wood falls to drag chains which take it to a single-deck Link-Belt screen and a Mitts & Merrill 100-hp. bark crusher which prepare the wood refuse for firing in the spreader stoker equipped bark burning boiler.

Debarked wood travels up inclined conveyors to two 88-in.

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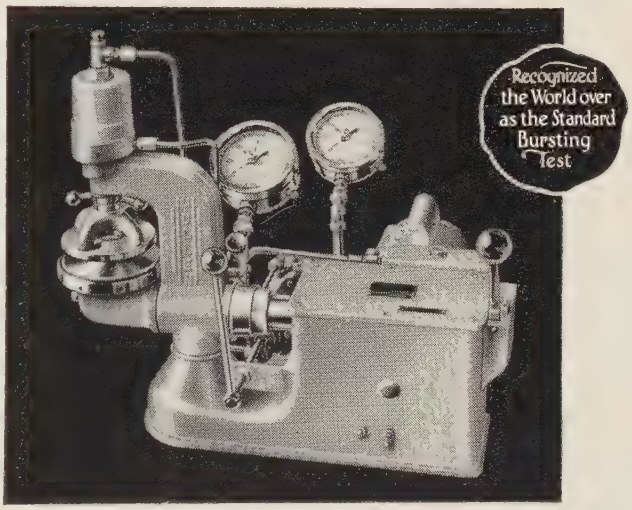

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Woodyard with drum barkers and woodroom in background at the new Jacksonville mill

10-knife chippers, built by D. J. Murray Manufacturing Co., each V-belt driven by a 400-hp., 720-r.p.m. motor. Bucket elevators convey the chips to four feeder equipped Link-Belt vibrating chip screens. Oversize chips and slivers are carried to a 36-in. hammermill chip crusher, built by the D. J. Murray Manufacturing Co., and are then returned to one of the elevators. Sawdust and fines drop to a 36-in. belt conveyor, which also receives crushed bark outside the wood room, for the beginning of its travel overhead to the bark boiler.

Accepted chips travel on a 36-in. belt parallel to the bark conveyor and up an incline to be distributed by a 36-in. conveyor with tripper to three 42-ft. diameter steel silos 65 ft. high.

Link-Belt chip silo discharge feeders are 17 ft. in diameter and are of the rotary plate type driven through a large ring gear and pinion, and are arranged to deliver the chips at a steady rate to a 42-in. belt. This conveyor takes chips to the digester building. Near its upper end, the conveyor passes over a Merrick Scale Manufacturing Co. weightometer and a magnetic pulley which removes any stray particles of metal.

Pulp Mill

The digester building is 30 ft. wide by 82 ft. long and has a 36-ft. ell which houses the measuring tanks and turpentine recovery equipment. There are four digesters, 46 ft. from flange to flange and 12 ft. inside diameter, 4000 cu. ft. volume, furnished by Chicago Bridge and Iron Co. Electric Steel Foundry Co. circulating systems are installed, with Bingham pumps and provision for future indirect cooking. Blow valves, by Paul Valve Corp., are operated by hydraulic equipment made by the Racine Machine and Tool Co.

A 48-in. belt shuttle conveyor, furnished by Link-Belt Co., is used for filling digesters with chips through an overhead rail mounted movable hopper. Automatic digester controls for cooking and relief are furnished by the Bristol Co.

The digester blow tank, furnished by the Chicago Bridge and Iron Co., has an Impco agitator. Heat recovery equipment consists of a blow steam condenser, accumulator tank, circulating pumps, regulators, strainers, and heat exchangers, all furnished by Foster Wheeler Corp., who also supplied equipment for a crude turpentine recovery system.

The washer room is an extension of the digester room ell, 36 ft. wide and 95 ft. long and contains three 11-ft. 6-in. by 16-ft. 0-in. Impco brown stock washers with repulpers and a vibratory deknotter.

Three filtrate tanks 35 ft. in diameter by 30 ft. high, and one foam tank, 24 ft. in diameter by 50 ft. high, furnished by Chicago Bridge, are located in the tank area adjacent to the washer room and alongside the blow tank and heat recovery equipment.

The washer hood and exhaust system is by Jamar-Olmen Co., of Chicago and New York, with whom Drew Engineering Co., of Portland, Oreg., collaborated on general and detail design. It includes a transite panel-type hood which extends over the washers and deknotter, and two 48-in. Sturtevant axial flow fans discharging vertically through the roof.

Brown Instrument Co. instrumentation and control are used for the brown stock washing installation.

The screen room building is 74 ft. wide by 110 ft. long and contains 22 Impco 14-plate flat screens installed in lines of two screens per line, arranged for 16 primary screens and 6 tailings screens, the latter being provided with scrapers. Screen rejects are discharged to a Bauer refiner or to a rejects storage chest when the Bauer is out of service. There are two vacuum deckers furnished by Impco which have cylinders 8 ft. in diameter by 12 ft. long, and peg-roll repulpers, discharging vertically into 14-in. diameter screw conveyors. These conveyors reverse so as to discharge either at high-density to a 24-in. belt conveyor furnished by Link-Belt, or directly to the decker chest, after dilution. The belt conveyor travels over an inclined bridge from the screen room to the high-density pulp storage tanks at the end of the beater room across the main plant roadway.

There is a screened stock chest 67 ft. long with seal pit and white water chamber in the basement of the screen room. A similar chest serves for in-process storage of washed stock ahead of the screens. These chests and pits, together with the 15-ft. diameter screen rejects chest, are constructed of Semtile furnished by the Stebbins Engineering and Manufacturing Co.

Chemical Recovery and Liquor Making

The sextuple effect evaporator, furnished by Goslin-Birmingham Co., is equipped with Labour liquor pumps, Worthington condensate and liquor transfer pumps, a Goulds pump for cooling water to the evaporator condenser, and a Kinney gear pump for soap handling.

The recovery boiler is designed to burn 900,000 lb. of dry solids per hour. Furnished by Combustion Engineering-Superheater, Inc., it produces 134,000 lb. per hr. of steam at 625 p.s.i. and 750° F. An Elesco special design superheater, water wall furnace, Diamond soot blowers, economizer, and D. J. Murray cascade evaporators are included in the design. The induced draft fan is furnished with an American Blower Co. Gyrol fluid drive. The recovery building, of which the main part is 50 by 63 ft. and over 100 ft. high, has an Otis 7-stop, 2500-lb. elevator.

Salt cake is unloaded from box cars, delivered to storage bins, and transported from storage to a process supply bin by means of a Fuller Co. Airveyor System. This system employs a Rootes-type exhauster, a four-compartment cam-operated filter, a rotary discharge lock, a motor-operated gate, and a single-stage cyclone receiver, 12-in. Jeffrey screw conveyors, pan feeders, and pulverizer, and Fuller high level bin indicators. Two bins 31 ft. in diameter and 65 ft. high, with conical tops and bottoms are by Chicago Bridge and Iron Co.

Two electrostatic precipitators are furnished by the Koppers Co. for the recovery of chemicals and the abatement of odors in the spent gases from the recovery boiler. This equipment is of generous capacity in line with assurances given by the company to the people of the community at the inception of the project. Each precipitator is designed to handle the total flue gas volume with the other one available at all times as a spare, and each unit is furnished with a complete set of auxiliary equipment. Removal efficiency of 95% is guaranteed, which sets a maximum not to exceed, 125 grains per

cubic foot of residual dust at the precipitator under normal operating conditions. The stand-by precipitator can be kept warm at all times and ready for instant startup. Some slight color will remain, of course, in the stack gases, but it is felt that the company has gone farther than is customary in the industry in line with its well-known policy of being a "good neighbor." In addition to the benefits from good public relations, there will be substantial economies in the recovery of chemicals, which will help eventually in paying off the heavy investment required by this type of equipment.

In the causticizing plant, there is a Dorr Co. lime slaker; also, three causticizing reaction tanks, a green liquor and white liquor clarifiers, mud washing and thickening tanks, and a dregs washer. In addition, the Worthington liquor pumps, Dorrco underflow pumps, an Oliver United mud filter and lime mud filtrate pump, a Nash vacuum pump for the lime mud filtrate receiver and Ross feeders for new and reburned lime, lime handling elevators and conveyors are all furnished by Dorr Co. The special water-jacketed kiln feed conveyor is furnished by Link-Belt.

Fresh lime is unloaded from box cars and delivered to storage by means of a Fuller Co. Airveyor System, which includes a Rootes type exhauster, a four-compartment cam-operated filter, and a rotary discharge lock. Fresh lime and reburned lime bins 18 ft. in diameter are made by Hammond Tank Co. who served as subcontractor on these and all other tanks furnished by Dorr Co.

The lime kiln is 9 ft. in diameter by 175 ft. long furnished by Traylor and is served by a Coen fuel-oil firing system. To recover the dust in the gases from the kiln, a Rotoclone unit, furnished by the American Air Filter Co., is erected at the discharge end.

Steam Power Plant

To provide for the total steam requirements of the mill, there is, in addition to the recovery boiler mentioned above, an oil-fired power boiler capable of producing 160,000 lb. per hr. at 625 p.s.i. and 750° F. The Combustion Engineering-Superheater, Inc. design includes an Elesco interbank superheater, a tubular air preheater, a steam air heater, American Blower Corp. forced draft and induced drafts fans and Diamond soot blowers.

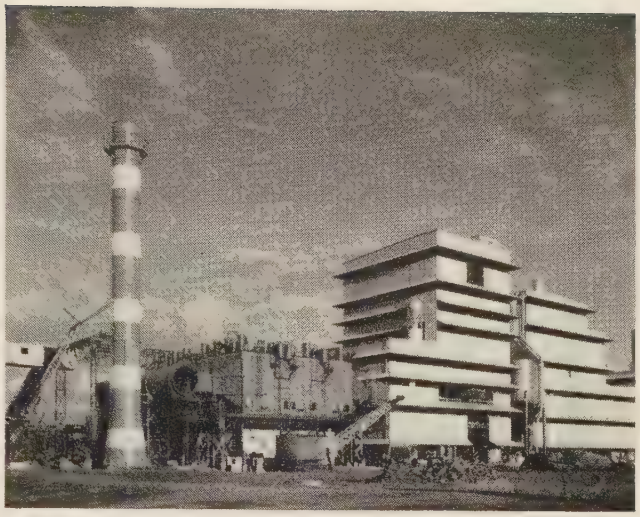
There is also a Combustion Engineering-Superheater, Inc. bark boiler capable of producing 135,000 lb. per hr. of steam at the above condition. The design includes an Elesco superheater, Diamond soot blowers, air preheater, continuous discharge spreader stoker with distributors, Reeves vari-speed drives for stoker and distributors, American Blower Corp. fans with Gyrol fluid drive on the induced draft, and a Western Precipitation Corp. Multiclone dust collector.

Three Ingersoll-Rand 7-stage feedwater pumps serve all three boilers; two are driven by 311-hp. Terry turbines and one is motor driven. There is a Worthington vertical jet deaerator and two stages of feed heating by means of tube and shell heat exchangers furnished by the Alberger Heater Div. of the Howard Iron Works, Inc., at Buffalo. Feedwater conditioning equipment is by Graver Water Conditioning Co. and consists of hot lime process sedimentation tank, chemical feeds, pressure filters, zeolite softeners, automatic desludging controls, Ingersoll-Rand backwash, booster and chemical pumps, and Milton Roy chemical feed pumps.

The Hofft Co., Inc., bark storage bin and multiple screw type bark feeding machinery has four Reeves variable speed drive units.

Electric Power Plant

The turbine room is 50 by 120 ft., adjoining the power boiler room and houses two 6000-kw., 4160-v., a.c., 0.8 power factor, General Electric turbo-generators and the electric feeder distribution switch gear. Each of these units is designed for operation with steam at the throttle of 625 lb. gage and a total



Precipitator and recovery units at the new kraft pulp, paper, and board mill of the St. Regis Paper Co.

temperature of 825° F., but will be operated at 750° F.T.T. One unit is provided with a 9500-sq. ft. Westinghouse surface condenser, condensate pumps, air ejectors and required auxiliary equipment and is arranged for the extraction of steam at 65 p.s.i. gage. The other unit is arranged for extraction at 165 p.s.i. gage and exhausts at a back pressure of 65 p.s.i. gage. The arrangement of electric power distribution from the turbine room switchboard consists of transmission at 4160 v. through feeders to the starting controls of the 4160-v. motors (200 hp. and above) and to several 1000 and 750-kva. transformer power centers located in the mill, from which the 440-v. distribution feeders are run to the various motor control and lighting centers.

Two Goulds pumps furnish brackish river water to the turbine condenser. These are located in a pump house at the water's edge, together with a Rex traveling water screen furnished by Chain Belt Co. A Wallace and Tiernan chlorinator is used to prevent the development of marine organisms in the system.

Paper Mill Buildings

The machine room is 83 ft. wide and 660 ft. long, with the first 140 ft. devoted to the refining equipment located on the operating floor and the stock chests, pumps, agitator drives, etc., on the ground floor below.

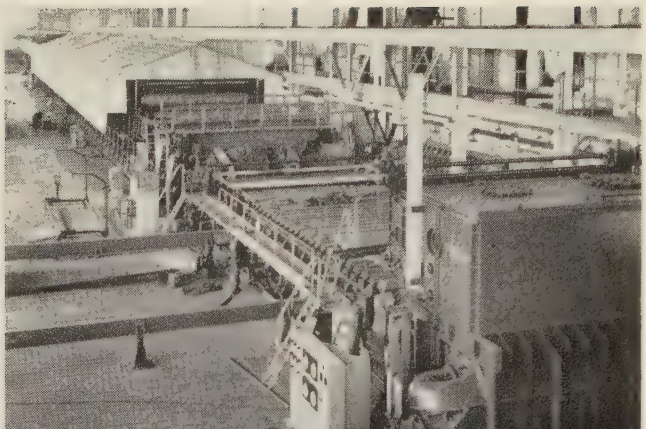
Beater Room

There are two, three-roll Victory beaters, each roll driven through V-belts by General Electric 300-hp. synchronous motors. Four Emerson jordans are driven by General Electric 400-hp. synchronous motors. Piping is arranged for any desired combination of beaters and jordans in order to provide maximum flexibility for primary and secondary refining and finishing treatments. The control cubicles for these motors and the exciter sets are located on the mezzanine floor which is continuous with the structure of the machine room.

An 8 by 16-ft. Oliver United vacuum saveall with tile vat is located on a platform extension of the mezzanine floor at the end of the stock preparation room. Stainless steel headboxes are provided for the beaters. DeZurik consistency regulators serve the beaters and jordans, respectively.

Two 30-ft. diameter storage chests for high-density stock are located outside the end of the beater room. They are constructed of Semtile by the Stebbins Engineering and Manufacturing Co. and are furnished with Impco propeller type agitators and hydraulic mining type nozzles.

Four concrete stock chests with midfeather are equipped



Wet end of the new St. Regis kraft paper machine

with horizontal propeller type agitators, furnished by Impco, and are located in the beater room basement.

Stock and water pumps are furnished by Goulds Pumps, Inc. and piping for stock and white water lines is transite with fabricated stainless steel fittings. All concrete stock chests and the various pits and chests under the paper machine are lined with Semplate tile by the Stebbins Engineering and Manufacturing Co.

Paper Machine

The Beloit Iron Works fourdrinier has a wire 230-in. wide by 120 ft. long. A Beloit patented cross flow distributor serves a Beloit pressure vacuum headbox with two rubber-covered rectifier rolls and an adjustable slice with two rectifier rolls having variable speed drive.

The breast roll is 32 in. in diameter and the forming board is stainless steel with Panelyte blades and mountings. The table rolls are of aluminum Panelyte covered, with stainless deflectors having Panelyte tips. There are ten stainless steel suction boxes. Wet boxes have Panelyte covers with slanting drilling and dry boxes have end grain maple covers. Wire guide and return rolls are of steel tube with heavy brass covers. Inside rolls need not be removed for wire change, which is accomplished by conventional Beloit removable fourdrinier. The Beloit high speed shake is a multiple unit driven by adjustable speed d.c. motor, each unit separately adjustable. There is a 24-in. diameter, open end, dandy roll, covered with bronze wire. The lumpbreaker roll is 20 in. in diameter with 2-in. thick special soft neoprene cover. The air roll is of aluminum with adjustable mounting, air cylinder for raising, and air wheel drive for starting. The saveall is of stainless steel carried on the main fourdrinier beam. The felt rolls are $16^{3}/_{4}$ in. in diameter, rubber covered.

The fan pump is of 30,000 g.p.m. capacity, furnished by Worthington and direct connected to a G.E. 350-hp., 450-r.p.m. synchronous motor. A Beloit tear-drop valve throttles the pump discharge. All stock and white water piping associated with the machine inlet is fabricated of stainless steel with horizontal runs sloped upward in the direction of flow to permit release of excess air, either to vacuum or to atmospheric vents. The fan pump suction is a short reducing elbow, 72 by 36 in. and 75-in. center to face.

The wire pit is arranged to give the utmost stilling effect for release of excess air. The connection on the bottom to the fan pump elbow is separated from the remainder of the pit by a longitudinal U-shaped dam. This causes the white water flowing in at the wet end to divide into two channels, thus passing first along the sides of the pit, then turning under the ends of the dam to the center, after which it flows back and down into the fan pump suction.

The press section is of Beloit vertical type, consisting of two 36-in. diameter rubber-covered suction rolls equipped with saveall and air-loaded packing holders and two 34-in. diameter top press rolls with 1-in. rubber covering. All top press rolls are carried on swing arms with air loading and air lifting equipment.

There are two Vickery felt conditioners, each having four jordan reverse type heads.

For water and air removal requirements, there are nine vacuum pumps made by the Nash Engineering Co. and furnished by Beloit as follows:

For the couch roll—three H-12A pumps; for the two press rolls—two H-11A pumps; for the flat boxes—one K-9 pump; for the felt conditioners—one K-7 pump; and for the felt box vacuum—one K-5 pump. All of the suction pumps are individually motor driven through multiple "HY-T" Synthetic fiber V-belts made by Goodyear and furnished by the Transmission Equipment Co.

The drier section of the machine consists of 71 paper driers and 18 felt driers, all 60 in. in diameter, arranged as follows: first drier section: 20 paper driers and 6 felt driers of which 2 are Feeney type; second drier section: 18 paper driers and 6 felt driers of which 4 are Feeney type.

The breaker stack consists of one bottom roll, 33 in. diameter, covered with $^{1}/_{2}$ in. Stonite; one top roll 34 in. diameter, covered with 1 in. rubber; located between the second and third drier sections. Third drier section: 18 paper driers and 4 felt driers of which 2 are Feeney type.

The size press consists of one bottom roll, 33 in. diameter covered with $^{1}/_{2}$ in. White Stonite; one top roll 34 in. diameter covered with 1 in. rubber; located between the third and fourth drier sections. Fourth drier section: 15 paper driers and 2 felt driers.

All of the driers are designed for operation at 125 lb. steam pressure. Drier bearings are heavy duty Torrington spherical roller self-aligning type with back bearings mounted outside the drive gears and front bearings arranged for expansion. Drier frames are box type, with back frame completely enclosing gears and bearings. Helical gears of small diameter are arranged for indrive at one point in each section. All felt driers are driven by the felt.

The Bowser circulating oil system, furnished by Beloit, is complete with tanks, pumps, filters, and regulating equipment installed on the ground floor and serves the drier bearings, drier drive parts, felt roll bearings and calender stack bearings.

A low pressure blower system is supplied to keep a slight pressure in the drive gear enclosure frames to minimize foam and vapor condensation. Lodding doctors with air oscillation are provided for the first bottom driers and last top driers in each section. The entire drier section is equipped with automatic rope paper carriers. Also, a short rope carrier is provided at the reel.

A Midwest-Fulton drier condensate removal system is installed. Drying is controlled by means of Taylor pressure recording controls on the first two drier sections, and Stamm moisture controls, provided also with pressure control, for the third and fourth drier sections.

Two Beloit open-sided calender stacks are provided with 34-inch diameter king rolls and seven 16-inch diameter intermediate and top rolls. All rolls have flexible blade doctors air loaded. Bottom doctors are oscillating type. Each stack has motor-operated roll lift and air loading.

The reel is a Beloit heavy duty type having a 36 in. diameter drum, taking a maximum 84 in. diameter reel of paper. The unwinding stand has adjustments for aligning the reel spools across the machine and in the machine direction. Regenerative braking is employed. The winder is a Beloit extra heavy duty machine with two 20-in. drums with individual motor driving each drum. Designed for a maximum

oed of 4500 f.p.m. the winder is equipped with motor-driven h-ar type back slitters, rider roll lift, and roll ejector.

The paper machine is designed, and all rolls are balanced, o- a maximum mechanical speed of 2500 f.p.m. Practically ll rotating parts are provided with antifriction bearings, e erally of Torrington manufacture.

Pneumatic systems for the paper machine are served by hicago Pneumatic Tool Co. compressors. The essential ir compressor serves the headbox, slice seal, fourdrinier, r sses, drier felt auto guides, breaker stack, and size press. ther services are taken from the main mill supply header.

Equipment is on order for an inverse second press, conver- i n of present first and second presses to suction transfer r ss and first suction main press, respectively, and the addi- i n of a suction pickup roll, wire turning roll, necessary felt q ipment, Vickery conditioner, vacuum pumps, and machine c es.

i sts

The machine room crane is of twin box girder bridge design w h two 15-ton trolley hoists, made by Ederer Engineering C Reel crane is a 20-ton overhead bridge with fixed hoist m le by Manning, Maxwell, & Moore, Inc.

i Systems

The transite panel hood is 256 ft. long with seven exhaust o lets to 72-in. axial flow fans driven through V-belts from m tors located on the machine room mezzanine floor over the r e aisle back of the machine. Also included are a calender c ling system, trim conveying system, dc motor ventilation, e ctric room ventilation, lower felt air systems, finishing o m supply, machine and beater room, roof supply systems, n cluding summer cooling, a Deco high-jet system, auxiliary w t end roof exhausts, a hydrapulper exhaust system, and a i nder and core sawdust collecting system.

All heating and ventilating apparatus and distribution are y Jamar-Olmen Co. of Chicago and New York, with whom D rew Engineering Co. of Portland, Ore., collaborated on e neral and detail design.

In addition to the paper mill systems and the brown stock o od and exhaust systems mentioned above, there are two o nstant temperature and humidity rooms, a precipitator o ntrol room ventilation system, and four electrical center e ntilation systems.

Hydrapulper

An 18-ft., Shartle Brothers Machine Co. hydrapulper is l cated to receive broke directly from the last drier, from e ther calender, or from the reel. It also receives trim from t e winder through pipe ducts. A stainless steel collecting c pper made by W. L. Rives Co. of Jacksonville serves the h drapulper. This arrangement eliminates the necessity f r a broke man since everything is controlled from the back- e nder's station. It also permits keeping an orderly base- m ent.

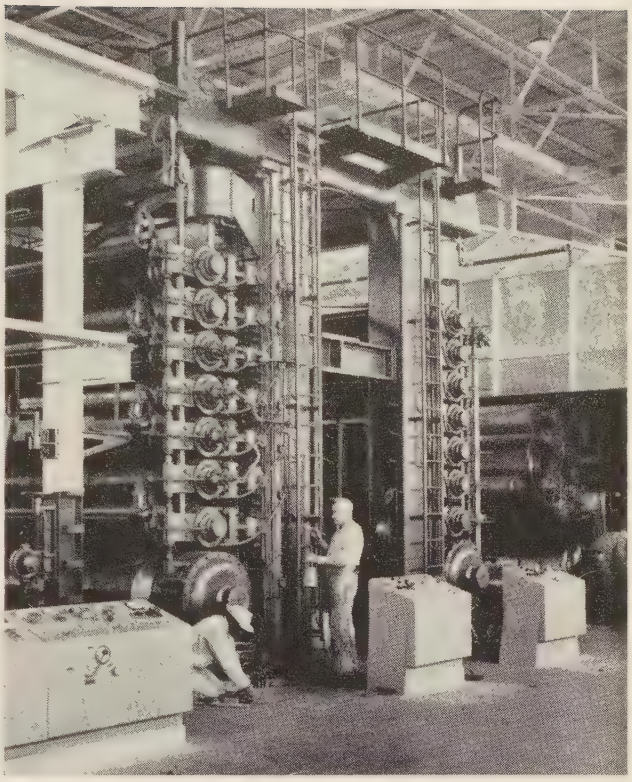
Paper Machine Drives

The General Electric sectional electric motor drives have F rrell-Birmingham herringbone reducers and are energized f m multiple motor-generator sets with electronic amplidyne r gulation. These include two 1500-hp 4160-v. synchronous m tors driving individual generators for all sections from r ach to winder, all installed in two separate enclosed elec- t ical rooms on the ground floor of the machine room.

The paper machine drive has General Electric electronic c ntrol, with speed regulators for each section plus potentiom- e er maintenance of sheet tension at the dry end. Photo- e ectric equipment stands guard over drier felt alignment and s irt actuation in case of breaks.

Finishing Room

The finishing room is a 240-ft. extension of the machine



Calender stacks in the new Jacksonville mill of the St. Regis Paper Co.

building. Equipment includes rotary cutters with backstands and 110-in. duplex layboy furnished by Moore & White Co.; a Harris Seybold trimmer with backgauge travel; a 15-ton hydraulic elevator furnished by Otis Elevator Co.; a rewinder with unwind stand and an automatic roll ejector furnished by Langston; and in the basement, a Link-Belt paper roll upender. Other finishing equipment, located in the end of the paper machine room, includes a roll wrapping machine with backstand and a roll heading machine furnished by Lamb-Grays Harbor Co. of Hoquiam, Wash.; also, a Link-Belt Lowerator for lowering rolls to the first floor and a Link-Belt floor type paper roll conveyor 75 ft. long for transporting rolls sideways into alignment with finishing room equipment.

General Features of Construction

In general, the pulp mill buildings consist of structural steel framework on concrete foundations, with concrete floors and corrugated transite siding on steel girts. The paper mill buildings are similar except that all framing up to the machine floor is of concrete. All windows in the paper mill, chipper and turbine rooms, are H. H. Robertson Co.'s corrugated Mississippi wire glass furnished by the Pittsburgh Plate Glass Co. The pulp mill buildings and power plant have corrugated transite open canopies without windows of any kind. All major buildings have precast concrete tile roof slabs, supported on steel purlines and covered with Barrett built-up roofing.

Office buildings have concrete columns, floors and roof slabs, and insulated walls faced with yellow brick. Large windows with intermediate panels of yellow brick give all three buildings a very pleasing, modern style. The architecture and engineering for these buildings are by Celli-Flynn, Architects of McKeesport, Pa.

The Administration Building has an attractive entrance lobby on the southwest corner of the south wing, which also contains a general office, offices for the Woodlands Division of the company, a lunch room, and other employee facilities

The north wing contains offices for the Resident Manager, for the Engineering Department, and for the Accounting Department; with vaults, duplicating, supply and conference rooms, and a general office serving the whole area.

The Employee Facilities Building consists of three separate buildings under a common roof, with generous time aisles and covered walkways between. The Personnel Department is located in one unit, an excellently appointed cafeteria in another, and locker rooms for all mill employees in the third and largest, which measures 55 ft. wide by 85 ft. long. Many large panels of glass block add to the attractive appearance of the locker rooms.

The Mill Offices are housed in a two-story building, 40 ft. wide and 80 ft. long. The general superintendent's office, and offices for the various operating supervisors, are located on the ground floor, together with a conference room of generous size and other facilities. The laboratories and chief chemist's office are on the second floor, which has ready access by bridges to the turbine room, beater room, and screen rooms.

Water Supply and Fire Protection

Water for the new mill is taken from two Layne-Atlantic Co. wells of generous capacity. Three smaller Layne-Atlantic wells are provided for observation and permanent record of the water table in the vicinity. The water purification system is by Infilco, Inc. of Tucson, Ariz., and consists of a 12,000,000 g.p.d. accelerator for selective lime softening, coagulation and clarification, water control and proportioning equipment, chemical feeding equipment, a turbidity detector, a Milton Roy alum pump, a Wallace and Tiernan chlorinator, and Builders-Providence controls.

There are two Peerless fire pumps of 1500-g.p.m. capacity at 230-ft. head furnished by Food Machinery and Chemical Corp., one of which is motor driven and the other driven by a Terry steam turbine. The fire tower is a 100,000-gal. elevated tank 175 ft. high, furnished by Chicago Bridge and Iron Co.

There is a complete underground fire protection system with 30 hydrant stations outside and Grinnell automatic sprinkler systems in all enclosed buildings, chip silos, bark bin, and conveyors, all furnished by Moore Pipe and Sprinkler Co. of Jacksonville.

International Pure-Pak

A new converting plant for the production of Pure-Pak paper milk containers will be constructed by International Paper Co.'s Single Service Div. in Youngstown, Ohio. Plans call for a modern brick and steel building of 63,000 sq. ft. designed to provide attractive and completely sanitary working conditions. All manufacturing areas of the single-story structure will have tiled walls. Floor design and equipment layout will be planned to maintain the highest standards of cleanliness.

The new plant will be designed initially to convert approximately 1000 tons of bleached kraft board per month, an average production of approximately 45,000,000 Pure-Pak milk containers of various sizes. Roughly 50 employees will be required when production begins probably building to about 100 as the new unit approaches full production.

International Paper Co.'s Single Service Div. produces Pure-Pak paper milk containers from bleached kraft board under license from the Excello Corp. of Detroit. Other converting plants of the Single Service Div. are located in Norristown, Pa.; Kalamazoo, Mich.; Kansas City, Kan.; Atlanta, Ga., and Bastrop, La.

West Virginia

The West Virginia Pulp and Paper Co. has six mills, each a fully integrated manufacturing unit with its own pulp, power, and papermaking facilities. These mills have the capacity to produce in excess of 800,000 tons of paper and paperboard per year.

At the end of World War II these mills, although excellently maintained, in some cases needed modernization due to t inability of the company to replace equipment under wartir conditions. Accordingly, in 1945, the company began extensive program aimed first at achieving maximum opera ing efficiency and quality control through modern technolo and, second at expansion in the product lines showing greate promise. To data a gross investment of $85,000,000 h been made for this purpose.

The Charleston, S. C., plant now has a daily capacity excess of 900 tons for the production of kraft liner board ar kraft paper. It is equipped with two large high-speed m chines, the second of which was installed in 1947. In 19 the first machine was rebuilt so that at the present time it one of the largest in the world. Scheduled for completion fiscal 1953 is a new pulp mill which will add further to th mill's capacity, and also enable it to use the hardwood speci available in its area.

The Covington, Va., plant has a capacity to produce ov 600 tons per day of white converting paper and board, kra envelope paper, and corrugating and fiberboard. It is no equipped with seven paper machines and three board machine In the past few years the three largest of the paper machin have been almost completely rebuilt so that they will run higher production rates. Scheduled for completion in fisc 1953 is a new high-speed paper machine, which will repla two of the smaller machines.

In 1952 the three existing pulp mills of this plant we replaced by a single new facility of greater capacity. Th new unit will operate at lower cost than the previous one and is better designed to utilize both pine and hardwoods the area.

The Luke, Md., plant has a present daily rated capacit of 335 tons of white printing, fine, and converting paper It is equipped with seven paper machines. Since 1945 fou of these machines have been equipped with machine coatin units, and during fiscal 1952 the two largest machines we completely rebuilt to increase their output and efficienc Construction currently in progress in the pulp mill is designe to increase its capacity by 100 tons per day and perm greater use of the abundant and lower cost local hardwood

The Tyrone and Williamsburg, Pa., plants have capacitie of 145 and 85 tons per day, respectively. They produc white printing, fine, and converting papers. The wate supply available, although entirely adequate for present pr duction, limits the capacity to which these two mills can b expanded under present technology. Therefore, the em phasis has been and will be, for the foreseeable future, o cost and quality control. Both of Williamsburg's pape machines and one of the four Tyrone units have been partiall rebuilt and had machine coating units added.

The Mechanicville, N. Y., plant has six paper machine which, together, produce 250 tons a day of white, fine, an converting papers. The most important recent developmer at this mill occurred in 1952 when a new semichemical pul mill designed to use nearby hardwoods was brought into pr duction, replacing one of two previously existing units. Th new pulping process also gives a substantially higher yield paper making fiber per cord of wood used.

Lord Baltimore

In announcing development of a new process for printin realistic photographs on waxed food cartons, Leonard Dals mer, Executive Vice-President of The Lord Baltimore Pres noted package printing specialists, revealed that his fir has already started producing newly designed full-color pac ages for two leading oleomargarine manufacturers.

With the removal of laws in most states restricting the pr coloring of margarine, retail margarine sales jumped 1952 to a record-breaking level of about $400 million, increa ing annual per capita consumption to an estimated 7.7 l

Under the new method, perfected by Lord Baltimore tec nicians, and identified as the "Fidel-i-tone" process, ful

olor photographs are printed directly on uncoated white oboard. Instead of conventional 110 line screen reproduction, however, the "Fidel-i-tone" process yields 175 line screen ork which brings out textural qualities unmatched, accordng to Mr. Dalsemer, in wax carton printing. In a square ch of 110 line screen work there are some 12,000 minute dots, hile under the unique Lord Baltimore process more than 0,000 dots appear, rendering a more lifelike image.

Founded in 1875 in Baltimore, The Lord Baltimore Press oday makes hundreds of millions of folding boxes, labels, nd inserts annually for foods, cosmetics, tobaccos, soaps, edicines, and other consumer products, by "Fidel-i-tone," thography, letterpress, and gravure.

stern Michigan College

A major expansion in the paper technology curriculum at Western Michigan College is now being planned for the fall semester of 1953, based on experience of the last five years.

A great demand has developed for trained personnel in the sales-management area, both in the paper industry itself and those firms who supply goods and materials to the papermakers. These varied businesses want men who know the technical background of papermaking and are also well grounded in business fields.

A comparison of the two courses of study shows that the technical students will place their emphasis on the more advanced mathematics and chemistry courses, while the sales-management students will spend extra time in business courses. However, both will receive a full course in papermaking.

First-year studies will closely parallel, but in the second year the technical students will get calculus for eight hours and the sales-management group will have six hours of business studies. Third year technical students will take wood chemistry and in the fourth year physical chemistry, will write a thesis, and study bleaching and deinking. The other phase will devote a correspondingly greater amount of time to advanced business studies subjects.

Along with these curricular changes comes a slight change in title. Since 1948 it has been known as pulp and paper technology, but from now on it will be known simply as paper technology, it being believed that the shorter title is broader in its connotation. The paper technology curriculum is a part of the chemistry department and is sponsored jointly by that department and the division of vocational and practical arts.

Michigan State

Michigan State College has announced the publication of a brochure entitled "Your Career in Packaging." This four-page folder describes the opportunities in the packaging field and outlines in detail the packaging curriculum at the institution. Copies may be obtained from the Department of Forest Products, Michigan State College, East Lansing, Mich. Limited quantities of the brochure are also available for organizations interested in the promotion of packaging education.

Mead

William H. Teter, who has headed the papermaking at the Kingsport Div. of The Mead Corp. at Kingsport, Tenn., since 1926 and has been responsible for all production of the mill since 1933, has been promoted to the new post of corporate director of planning for the Kingsport Div.

In his new position, Mr. Teter will be a member of the corporation's Engineering and Development Committee, which is headed by C. R. Van de Carr, past Mead president. He will continue to make his headquarters in Kingsport, Tenn. where he has lived since 1926.

To fill the position of production manager of the Kingsport

William H. Teter, The Mead Corp.

E. H. Niederauer, The Mead Corp.

Div. vacated by Mr. Teter, Edward H. Niederauer has been promoted from assistant manager of the Escanaba Paper Co., Escanaba, Mich., another Mead division. Mr. Niederauer was transferred from Kingsport to Escanaba in 1946 as general superintendent. His return to Kingsport, where he had been technical assistant to the production manager, marks his fourth period of residence here.

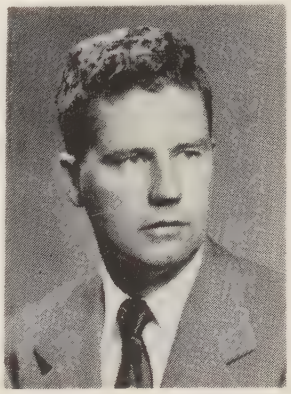
John R. Taggert has been promoted to assistant production manager at Kingsport. He had been assistant to Mr. Teter since 1950.

At Escanaba. O. C. Christiansen has been promoted from assistant to the plant engineer to paper mill superintendent, and Clark Greenles has moved up from paper mill day foreman to assistant paper mill superintendent. Henry Abel has replaced Mr. Greenles as paper mill day foreman.

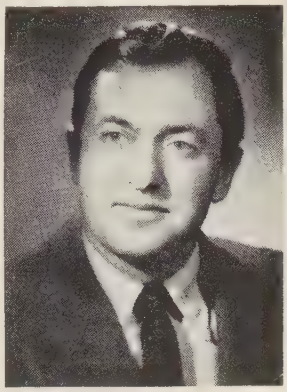
The Board of Directors of The Mead Corp., has elected A. Rodney Boren assistant vice-president for paperboard. Boren, who has been working in Mead's paperboard sales since August, 1949, has been assistant to Alan Goldsmith, vice-president. He is also a director of Mead Board Sales, a company affiliated with Mead, and headed by Mead vice-president, Al H. Mahrt. Boren's office is in Dayton, Ohio. His responsibilities will continue to be associated with the paperboard activities of the company, including the coordination of manufacturing and sales programs and policies. Before he joined Mead, Boren had worked for the H. S. Boren Co. general contractors in Dayton, and the Dayton Coca-Cola Co.

Gair

On February 1, J. D. Malcolmson, well-known packaging expert, moved to Berkeley, Calif. He has relinquished his duties as manager of the Products Development Department of Robert Gair Co., Inc., New York, but will remain on Gair's staff and, among other things, continue to represent the company on various committees on which he now serves.



O. C. Christiansen, The Mead Corp.



A. Rodney Boren, The Mead Corp.

Mr. Malcolmson has been in the paperboard industry since 1916, and with the Gair company since 1922. He is a graduate in chemical engineering of the University of Kansas, and was a Fellow of the Mellon Institute of Industrial Research Pittsburgh, Pa., from 1916 to 1922, the last four years of which (1918–22) he was on research work for the National Container Association where the first technical study of the corrugated box was made.

Mr. Malcolmson was, for two years, Packaging Vice-President of the American Management Association. Also, he is the only representative of the paperboard industry on the Munitions Board Packaging Advisory Committee. He is chairman of several United States Department of Commerce Simplification Committees on boxboard products. . . .a member of the American Society for Testing Materials, member of the Executive Committee of the Technical Association of the Pulp and Paper Industry, and is on several container committees in these societies. He is on the Board of Directors of the Packaging Institute, and chairman of the Technical Advisory Committee of the Fibre Box Association. In 1944, he organized the Technical Section of the Paperboard Div., War Production Board, and served as Chief of that section. Since 1918, he has written a great many articles on the subject of paperboard shipping containers.

Packaging Institute

The annual Spring luncheon meeting of the Packaging Institute will be held in Chicago during the National Packaging Exposition on April 20 at the Furniture Club, 666 Lake Shore Drive, according to an announcement by Robert de S. Couch, of General Foods Corp., president of Packaging Institute.

The luncheon, to which all who are interested in packaging are invited, will begin at 12:30 p.m. on Monday, the first day of the Exposition, and will be featured by a talk by F. S. Leinbach of Riegel Paper Corp., General Chairman of Technical Committees, and an announcement of the organization of the newly created Package Printing Div. by E. H. Balkema of Colgate-Palmolive-Peet Co., Chairman of new Division of Technical Committees, followed by meetings of several of the Technical Committees during the early afternoon.

Tickets are available from the Packaging Institute, 342 Madison Ave., New York 17, N. Y., at $3.75, but their sale will be limited to 200 persons by the size of the available accommodations.

University of Toronto

The appointment of Dr. W. Howard Rapson as professor of chemical engineering at the University of Toronto has been announced by Dr. Sidney Smith, the president.

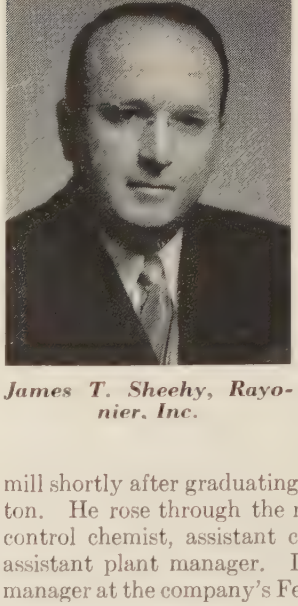
Dr. Rapson will lead the department's activities in pulp and paper research. A U. of T. graduate in chemical engineering, he has had 12 years' research experience with the Canadian International Paper Co. and Industrial Cellulose Research, Ltd., at Hawkesbury, Ont. He specialized in pioneering research and was responsible for the development of many new ideas and processes and, of equal importance in chemical engineering, their application in mill practice.

Dr. Smith said the appointment was a significant development in the university's efforts to serve the pulp and paper industry which is such an important element in the national economy.

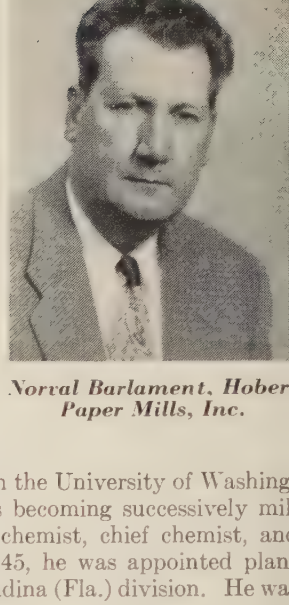
Rayonier

Election of James T. Sheehy to the board of directors of Rayonier, Inc., was announced by Clyde B. Morgan, president. In addition to his new responsibilities as a member of the board, Mr. Sheehy, as executive vice-president, directs the production, research, finance, sales, timber, and other operations of the chemical cellulose producer.

Mr. Sheehy, who is 42, went to work with Rayonier in 1933 as a pulp tester at the company's Grays Harbor (Wash.) mill shortly after graduating from the University of Washington. He rose through the ranks becoming successively mill control chemist, assistant chief chemist, chief chemist, and assistant plant manager. In 1945, he was appointed plant manager at the company's Fernandina (Fla.) division. He was elected executive vice-president in January, 1951.



James T. Sheehy, Rayonier, Inc.



Norval Barlament, Hoberg Paper Mills, Inc.

Hoberg

Norval Barlament, former Chief Engineer at the Hudson Sharp Machine Co. has joined the engineering staff of Hoberg Paper Mills, Inc. Barlament has charge of all engineering problems and future development of the company's converting department. This will include improvement of existing machinery plus the design and development of new machinery to make converting operations as efficient as possible, according to Auchter. Starting out with Hudson-Sharp 24 years ago as a shop worker, Barlament later advanced to a selling and servicing position prior to World War II. During the war he was assembly superintendent. He was appointed chief engineer in 1945.

Valite

Brown & Root, Inc., of Houston has announced plans to build a plant to make newsprint paper from sugar cane bagasse for the Valite Corp. of New Orleans.

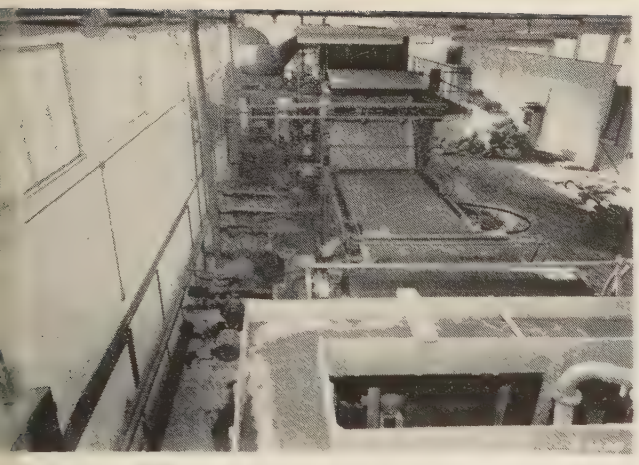
The new plant, pending approval in Washington, will be located at Lockport, La., and will process approximately 17,250 tons of paper and dissolving pulp annually in the initial stages. The firm has filed an application for accelerated depreciation with the national production authority.

The new corporation will be the Valentine Pulp and Paper Co. Upon approval, Brown & Root, Inc., will begin construction immediately with completion due late in 1953. The plant will employ some 70 industrial workers.

Bagasse is the fibrous residue from sugar cane and thousands of tons go to waste annually in Louisiana. The Valite Corp.'s principal business is in the manufacture of plastics and resins from bagasse, and the development of the process to make newsprint paper has come after considerable research in many parts of the United States. Newsprint paper of 100% whole bagasse pulp has been made and tests have been run on the presses of the Opelousas (La.) *World*, the Franklin (La.) *Banner Tribune*, and the *Lafourche Comet* (Thibodaux, La.). A small pilot roll was run for strength tests on the high-speed presses of the New Orleans *Times-Picayune* with satisfactory results.

Will J. Gibbins, president of Valite, said the new process would not only greatly benefit the economy of the sugar cane industry but would make available a new fiber source to the paper and pulp field.

"Within a hundred miles of the site of this factory in Louisiana, 750,000 tons of bagasse are produced annually and only



The paper machine in Israel's first paper mill

ut 200,000 tons are being commercially utilized. The ainder is being burned. Although the annual capacity this plant will be small compared to the demands of news- t consumers, the factory can be easily expanded and the put greatly increased," he said.

RATHON-NORTHERN

A merger of Northern Paper Mills, Green Bay, into Mara- n Corp., Menasha, was announced recently.

John Stevens, Jr., president of Marathon, and Milan Boex, sident of Northern, said the action taken upon recom- endation of directors of both companies, is subject to ap- roval by Northern's stockholders. Mr. Boex said the mer- er will be based upon a tax-free exchange of stock with no ash involved.

Marathon, which reported revenue or more than $86,000,- 00 in 1952, principally from the sale of packaging for the ood industry and paper products for consumers, has plants t Menasha, Rothschild, Ashland, and Wausau, Wis., Men- minee, Mich., and Oswego, N. Y., wholly owned subsidiaries re located at Sunnyside, Wash., and in Canada.

Northern, which reported sales in the retail paper product ne of more than $21,000,000 in 1952, has a pulp mill and aper mill at Green Bay. It will continue to operate and its rade name will be retained.

Marathon has a pulp mill, chemical plant and townsite at Iarathon, Ont., and 5000 square miles of timber concessions 1 central Canada. Northern also has timber tracts in anada.

SRAEL

The cutting machine of Israel's first paper plant, the re-

Cutting machine in the new mill in Israel

cently opened Supra paper mill at Lydda, is located on the site of a former orange grove. At the left are the paper rolls which are sliced by the machine, and at the right the separate sheets of wrapping paper are picked up by manual workers in a temporary operation which will be superseded by a mechanized operation as funds become available for the purchase of additional equipment. The establishment of this new enterprise, which is expected to play its part in Israel's effort to build a modern, mechanized economy, was aided by American investments in State of Israel Bonds, and further expansion will depend to some extent on the progress of the Israel Bond drive in the United States.

C.P.P.A. Technical Section

In his report to the annual meeting of the Technical Section of the Canadian Pulp and Paper Association, Douglas Jones, Executive Secretary of the Section, featured the history and accomplishments of the organization. His remarks follow:

Much credit for the organization of the Section is due to John S. Bates, Roy L. Campbell, and C. B. Thorne, for their enthusiastic efforts in the developing of plans which were eventually embodied in its constitution by by-laws. Dr. Bates was then superintendent of the Forest Products Laboratories of Canada, Mr. Thorne was manager of the Riordan Pulp and Paper Co. at Hawkesbury, and Mr. Campbell was secretary of the Canadian Pulp and Paper Association, while at the same time serving in his capacity as editor of the *Pulp and Paper Magazine of Canada.* It is thus seen that the publishers and the editors of the Magazine have been constantly interested in the work of the Association and particularly of the Technical Section, ever since its organization. J. N. Stephenson was engaged in September, 1916, to follow Mr. Campbell as editor when the latter resigned to serve with a Canadian Trade Commission in Europe. Dr. Bates was the first chairman, and other officers consisted of Vice-Chairman T. L. Crossley and Councilors C. B. Thorne, Dan Daverin, and G. W. Dickson, with Mr. Campbell as Secretary-Treasurer. Besides these officers, there were on the various committees O. F. Bryant, Sigmund Wang, H. S. Taylor, C. F. Buss, O. Rolland, A. G. Pounsford, J. A. DeCew, A. O. Bowness, Fred Barnes, E. B. Slack, Bjarne Johnsen, and A. G. McIntyre.

Many of the distinguished contributors to the inception and development of the Section are now dead. These eminent men, leaders in the past, included Orville Bryant, C. F. Buss, George Carruthers, Bjarne Johnsen, Col. C. H. L. Jones, Bob McInnis, F. A. Sabboton, John Stadler, and C. B. Thorne.

What has happened since 1915 when a group of 22 pioneers formed the Technical Section, the first technical organization set up within the pulp and paper industry of North America? In those days the so-called "technical" employee in this industry was viewed with suspicion by most of those with whom he came in contact. Today, partly through his own efforts, and those of organizations such as the Technical Section, he is a valued employee and in many cases is a senior executive.

In the intervening period, the Technical Section has grown into an organization, known throughout the world, with a membership of over 1500. It now numbers in its membership executives, managers, engineers, control and research men, and a full complement of the operating personnel of the industry. Whereas in the early days exchange of information, technical or otherwise, between companies was practically, nonexistent, today, chiefly through the efforts of the Technical Section, there is a free exchange of ideas on all technical and operating developments, not only among Canadian mills but also among the mills throughout the world. The old antipathy between the so-called technical and so-called practical man has been replaced by a mutual feeling of confidence and respect. Each has helped the other and they work together for the continued benefit of their companies and the industry.

The growth of the Technical Section has been paralleled by a similar expansion of the industry. In the daily newspapers of the early twenties, there were reports by eminent foresters that our paper industry was denuding our forests and that if we continued to expand, our forests would be liquidated within 25 years. Today through the efforts of the Canadian Pulp and Paper Association, its Woodlands and Technical Sections, and the forethinking executives of the industry, we have a sound forest policy which provides that our mills will operate their forest areas on a sustained yield basis—and all this with an industry many times the productive capacity of that of the early twenties.

What are some of the accomplishments of the application of sound technical thinking and engineering? Increased machine speeds; reduction of percentage sulphite in newsprint; new and improved bleaching techniques; new machines in the field of refining of rejects; new processes and machines producing semichemical, high yield and continuous pulps; improved quality of pulps and papers produced; utilization of hardwoods, and so-called weed species; production of by-products such as yeast, vanillin, alcohol, and so on; utilization and elimination of wastes; and many more items which could be mentioned as contributions of those of our industry collectively referred to as the technical men.

Over the years ten branches of the Technical Section have been established. These branches give mill personnel in the areas concerned an opportunity to attend meetings to express themselves in public, to meet others in similar jobs, to visit other mills, and to advance their personal knowledge and consequently enhance their chances of future advancement.

In the early days of the Section there were four committees. One of these committees was the Standards Committee, now known as the Physical and Chemical Standards Committee. It reviewed developments in this field and brought them to the attention of the members. Guidance and assistance were also given in the development of testing methods and instruments. One of the committee's first projects was the improvement of the Wilen sheet machine. Another and a very outstanding contribution was the development and standardization of a freeness tester, the first models of which had been made and tried out experimentally at the Iroquois Falls mill of the Abitibi Power and Paper Co. Ltd. This work was carried out under the supervision of Rex W. Hovey, who was then Research Director of the Abitibi company, a very active member of the Technical Section and its chairman in 1924. The services of the staff of the Forest Products Laboratories were enlisted by members of the Standards Committee to develop this instrument as an industry standard. The use of Technical Section standard methods of testing and analysis of material is now routine throughout the industry. Other committees were established over the years and they have contributed in a large measure to the growth of the Technical Section.

Today we have seventeen active committees representing all branches of engineering and all phases of the industry's operations. Their special function is to promote cooperative study and exchange of information and experience within the industry. The activities of these committees result in the publication of reports or papers dealing with mill practices, new equipment or processes, and the planning of sessions or discussions at Technical Section meetings, and of conferences or courses on subjects of interest to particular groups. For example, the Process Instrumentation Committee has sponsored one course on the theory and application of instruments and another training course for instrument mechanics. Similarly the Pulping Division Committees in collaboration with the Fundamental Research Committee have sponsored a number of international conferences on various subjects.

In times of national energency, the Technical Section has played an important role in the solution of problems confronting the nation. For example, the Sulphite Committee played an important part in the industry's reduction of sulphur consumption following the decrease in supply. A major contribution of the Canadian industry to the war effort in World War II was the work of the Wartime Machine Shop Board. The idea that the well-equipped machine shops of the industry could serve Canada by turning out bits and pieces of essential war equipment was conceived by a member of the Section, Jim O'Halloran. His idea was brought to the attention of the Executive Council of the Technical Section, then placed before the Executive Board of the Association and after having been proved by Mr. O'Halloran and his company, Anglo-Canadian Pulp and Paper Mills Ltd., was adopted by the whole industry through the establishment by the Association of its Wartime Machine Shop Board.

One of the objectives of the Technical Section, that of encouraging and assisting original investigation, has been achieved in a number of ways. Voluntary committees working cooperatively cannot, of themselves, conduct extensive research. They do, however, stimulate and encourage research by awakening the interest of research groups in problems confronting the industry. This work was commenced in 1916 by the Advisory Committee of the Technical Section to the Forest Products Laboratories of Canada. The Montreal Laboratories some years later became the Pulp and Paper Research Institute of Canada. With Dr. Bates as chairman of the Section and at the same time superintendent of the Laboratories, and with the appointment of the Advisory Committee, the collaboration between the Section and the Laboratories became closer and more effective. The Laboratories through a program of fundamental research brought to light a wealth of basic information which could not have been discovered in the mill laboratories.

The earlier reorganization of the old Laboratories into the Pulp and Paper Research Institute of Canada and the erection of the present building was assisted in no small measure by the Advisory Committee referred to previously. The present expansion of the Institute is of prime importance to the Technical Section and excellent liaison is maintained with the Institute which, although a separate legal entity, is supported financially in part by the Canadian Pulp and Paper Association. The Institute, from time to time, includes in its program investigations suggested to it by committees of the Technical Section. These studies have resulted in improved techniques, valuable contributions to the technical literature and to the basic knowledge and understanding of the pulp and paper manufacturing processes. This close cooperation between the Institute and the Technical Section is of reciprocal benefit and assistance to the Institute staff and to our members.

Today, special emphasis is placed by the Section's Executive Council on the stimulation of basic or fundamental research, an activity that has long been a part of the continuing program of the Technical Section. The latest activity in this field was the special full-day session held under the auspices of the Fundamental Research Committee during the 1953 Annual Meeting, bringing together representatives of Canadian universities and Provincial and Federal Government research organizations with research personnel of our industry. This session reviewed some of the fundamental problems of the industry which might be undertaken at the universities by postgraduate students.

The application of the results of basic research is the duty of all technical men who are adequately equipped to assist this application to the processes of our mills. The Technical Section will maintain its support of both fundamental and applied research and will continue to assist the Institute in an advisory capacity through its membership, committees, staff officers, and Executive Council.

One of the objectives of the Technical Section is the dissemination of knowledge, one of the essentials of progress. The Section has been instrumental in collating and publishing

e best collection of data on the manufacture of pulp and per in a series of textbooks formerly published in five volumes nown as the "Manufacture of Pulp and Paper." The last ree volumes of these textbooks are presently being revised d issued as four new volumes now known as "Pulp and Paper Manufacture." Two of these volumes have been sued and the third will appear early this year.

The original five volumes resulted from the modest effort ars ago of the Committee on Education to establish classes in pulp and paper making in various mill centers in Canada. In the Summer of 1918 this committee met in Toronto and recognized the need for a suitable textbook in order to further the work that had already been done. Realizing that the American industry would also likely be interested in the production of a reliable and up-to-date treatise on pulp and paper manufacture, a joint meeting with the Education Committee of the Technical Association of the Pulp and Paper Industry was suggested. Such a meeting was held in September, 1918, and definite plans for the publication of the textbooks were made. An executive committee, representing both countries, and an editor were appointed and work was immediately begun even before there was any appropriation to cover expense. The plans proposed by the Joint Textbook Committee were approved by the Technical Section at the 1919 Annual Meeting and on the recommendation of the Section, the Canadian Pulp and Paper Association voted an initial $5000 to carry the work forward and subsequently voted further appropriations of $20,000. In the United States a similar amount was raised by private and company donations to the fund. Royalties accruing to the committee have been used to cover the cost of all revisions published since the first volumes appeared. To date the total sales exceed 57,300 volumes and the books are considered as standard works in their field. It is of interest to note that the editor originally appointed was a member of the Technical Section and he is still doing an excellent job with the newest revisions. I refer, of course, to J. N. Stephenson who is also, Editor-in-Chief of the *Pulp and Paper Magazine of Canada*, the Section's official publication. The original secretary of the committee, also still on the job, is Royal S. Kellogg, an honorary life member of the Technical Section. The two Canadian representatives on the committee are Harry S. Spencer, a past councillor of the Technical Section, and myself. Individual members and committees of the Technical Section have taken a very active part in the revisions of the textbooks through the years and in the major revision now under way. Only the generosity of many individuals and firms that have contributed their time and facilities has made possible the continued publication of these valuable textbooks. Over a hundred top-flight engineers of mills and manufacturers wrote, revised, and reviewed manuscript, provided illustrations or assisted with advice in the production of Volume 3. The Joint Textbook Committee is most grateful to them and to the committees of the Technical Section for their valued contributions.

The correspondence courses set up by the Institute of Industrial Arts on the recommendation of the Technical Section in January, 1922, have provided training facilities for over 2000 industry employees who have enrolled in the courses. These courses have now been turned over to the International Correspondence Schools.

Outstanding among the benefits derived from membership is the development of the qualities of initiative and leadership. Any reticence is overcome and initiative developed in the preparation and presentation of papers and participation in group discussions. Service on committees, branch executive, and ultimately executive council afford further opportunity of developing the characteristics of leadership.

The pulp and paper industry has been able to meet the needs of mankind everywhere only because the technical man has created new processes, developed controls, reduced waste, discovered new products, and made possible the vast production so essential to the modern world.

As literacy increases and the standard of living rises, so will grow the demand for pulp and paper. This increasing demand will present problems challenging the ingenuity and enterprise of the technical man. Present processes are not yet fully understood. Fuller utilization of raw materials must be achieved. Waste can be reduced still further. Many new products and by-products await discovery. Indeed the technique of converting wood into other products is still in its infancy.

The pulp and paper industry thus presents opportunities to those capable of pushing back the frontiers of the unknown, developing new markets and new products, and improving industrial skills. Thus membership in the Technical Section, Canadian Pulp and Paper Association, provides the wider knowledge, professional association, and the stimulation which engender initiative and enterprise, the basis of personal and industrial progress.

Such were the aims of the founders of the Technical Section in 1915 and they have presented a challenge ever since. In striving to meet them, much has been accomplished. And in the light of our past success we can look forward with confidence to even greater achievements in a future that will redound, not only to the benefit of our industry, but to each of us individually.

Westinghouse

Carroll B. Dick has been appointed Manager of the Westinghouse Electric Micarta Div., succeeding E. R. Perry.

Westinghouse, Box 2099, Pittsburgh 30, Pa., has issued a 24-page booklet pocket catalog (B-5799) on "Fluoroescent Luminaire."

Commonwealth Engineering

Phillip R. Marvin has been appointed Vice-President of the Commonwealth Engineering Co., Dayton, Ohio. Commonwealth has issued an interesting illustrated booklet outlining its facilities, for chemical, electrical, and mechanical research and engineering. In the paper industry it cites accomplishments in hot melt adhesives, strawboard treatments, paper gasket impregnants, heat sealing tapes, etc.

Appleton Woolen

Wallace Dumond has been appointed representative of the Appleton Woolen Mills, Appleton, Wis., to cover North and South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, and Texas. He will reside in Savannah, Ga.

Morningstar, Nicol

Morningstar, Nicol, Inc., New York N. Y., has purchased the Hayes Adhesives Co. of St. Louis, Mo. The firm will operate as an affiliate of Paisley Products, Inc., Chicago, Ill. Vernon Hayes will continue as local manager.

Calco

The Calco Chemical Div. of the American Cyanamid Co., Bound Brook, N. J., has issued Calco Bulletin No. 830 on "Dyeing Paper White." The contents was reprinted from *Tappi* 35, No. 8 (Aug., 1952).

Roots-Connersville

Roots-Connersville Blower, Connersville, Ind., has issued a 16-page booklet (Bull. M-152) on "Displacement Meters" for measuring gases of any type, and in quantities from 4000 to 1,000,000 cu. ft.

Raybestos-Manhattan

William S. Simpson has been appointed General Manager of the Stratford, Conn., Div. of Raybestos-Manhattan, Inc., succeeding Robert B. Davis, retired.

John F. Shea, Buffalo Electro-Chemical Co.

BECCO

John F. Shea, formerly Northeastern District Sales Manager, has been appointed General Sales Manager of the Buffalo Electro-Chemical Co., Buffalo, N. Y. Fred N. C. Jerauld has been appointed Manager of Sales Promotion. Becco is a division of Food Machinery and Chemical Corp., and manufactures hydrogen peroxide and active oxygen chemicals.

GOULDS PUMPS

Goulds Pumps, Inc. (Dept. TA), Seneca Falls, N. Y., has issued a new bulletin 721-6 describing its new 3405 centrifugal pumps which have capacity ranges from 200–6400 g.p.m., with heads up to 260 ft.

LAWRENCE DUCK

The Lawrence Duck Co., Lawrence, Mass. makers of papermakers cotton drier felts, is celebrating its 100th anniversary. The company received its charter during the same year that the City of Lawrence received its charter. The company is represented by William L. Barnell Co., Boston, Mass.

PENNSALT

Philip C. Staples has been appointed Chicago Sales Manager of the Industrial Chemicals Department of the Pennsylvania Salt Manufacturing Co. He replaces John C. Hampson, who has returned to Philadelphia as Product Supervisor in the same department.

RELIANCE

Cyril G. Veinott, nationally known electric motor design engineer and inventor, has joined the Reliance Electric & Engineering Co., Cleveland, Ohio, as Consulting Engineer on alternating current machinery.

MINNEAPOLIS-HONEYWELL

J. A. Robinson has been made Field Sales Manager for the Industrial Div. of Minneapolis-Honeywell Regulator Co., Philadelphia, Pa. He succeeds O. B. Wilson who was recently made Sales Manager of Industrial Instruments.

M.-H.'s Brown Instruments Div., Station 64, Brown and Windrim Aves., Philadelphia 44, Pa., has issued Catalog 1550 on "pH and Conductivity Recorders and Controllers."

HUYCK SYMPOSIUM

The annual sales meeting of F. C. Huyck & Sons, makers of papermakers felts at Rensselaer, N. Y., took the form of a symposium of sales managers. Participants included: Milton Bixby, Hercules Powder Co.; G. W. Knapp, General Electric Co.; William Metcalf, J. O. Ross Engineering Co.; P. F. Neuman, Hercules; D. F. Putnam, G.E.; and Fred Soderberg, General Dyestuff Corp., Greenville R. Holden, President of Huyck, presided as moderator.

GENERAL DYESTUFF

Robert J. Hamilton, Jr., has been appointed Advertising Manager of the General Dyestuff Corp., and Antara Chemicals Div., New York, N. Y. Mr. Hamilton has been with the company since 1929.

B. & W.

Babcock & Wilcox Co. has purchased 153 acres south of Wilmington, N. C., and will start immediately to build a 2 million dollar plant to build boilers and related equipment. The new plant will be ready in June, 1953.

BIGGS

Biggs Boiler Works, Akron 5, Ohio, has issued Bulletin 531 on "Steel Plate Fabrication" of stainless, carbon-moly, coated, clad or mild steels, welded or riveted to ASME specifications in heavy gage and wide widths for tanks, pressure vessels, rotary kilns, driers, etc.

ALLIS-CHALMERS

Allis-Chalmers Mfg. Co., 828 S. 70th St., Milwaukee, Wis., has issued a new leaflet "Integral-Shaft Type Motion Control Vari-Pitch Sheave Unit 20 S 7897" designed primarily for use on paper machine back lineshaft drives.

HOOKER

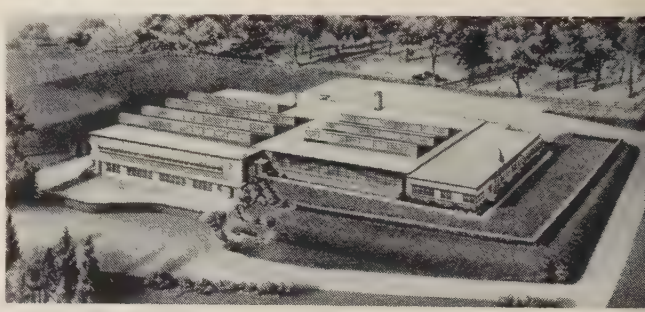
James S. Walker has been named Manager of Technical Service of the Hooker Electro-Chemical Co., Niagara Falls, N. Y.

R. W. Hooker, Vice-President, was recently re-elected for the fifth time President of the Chlorine Institute. The Institute engages in the technical promotion of the uses of chlorine, especially for the treatment of water and industrial wastes.

FOXBORO

The Foxboro Co., Foxboro, Mass., has issued a 16-page illustrated bulletin (Bull. 465) describing the "Foxboro Circular Case Controller." This instrument has been selected for more than 50,000 installations, to automatically control temperature, pressure, liquid level, humidity, or other process variables.

A new plant extension of the Foxboro Co. Ltd. at Montreal has more than doubled its instrument manufacturing facilities in Canada. 23,000 sq. ft. of factory space were added. The company located in Canada for 40 years is represented by Peacock Brothers, Ltd., as sales agents.



View of the Montreal plant of Foxboro Co., Ltd.

Combustion Engineering

R. C. Ulmer, feedwater specialist, formerly technical director for E. F. Drew & Co., has joined the Engineering Department of Combustion Engineering-Superheater, Inc., in New York where he will be engaged in development work.

Witco

Max A. Minnig has been made Director of Sales of the Witco Chemical Co., New York, N. Y. Mr. Minnig joined the company in 1946 in the Natural Gas Div., Carbon Black Operations.

G. E.

The General Electric Co., Schenectady 5, N. Y., has issued a new 28-page illustrated bulletin (GEA-5900) entitled, "Industrial Power Distribution Idea Book." It covers utility distribution practices; methods of buying electric power; what to do when a choice of primary voltages is available; application of primary switches and circuit breakers; types and arrangements of primary cables; and types of load-center distribution systems.

Lime

Pulp and paper mills consume roughly 600,000–700,000 tons of lime annually.

The industry is the second largest user of lime, being exceeded by the steel industry, using 1,400,000 tons. Calcium carbide and cyanamid uses 600,000 tons, water purification 300,000 tons. Together with users in the glass, nonferrous metallurgy, sewage, and waste treatment, leather, insecticides, petroleum refining, brick and other industries 4,720,000 tons of lime are consumed.

Pusey-Jones

LeRoy A. Grettum is the new President of the Pusey and Jones Corp., Wilmington, Del. He succeeds Andrew G. Spiegelhalter who has retired after 52 years of continuous service with the company. Mr. Grettum has been associated with P. & J. since 1946. Before joining the company he was President of the Eastern Oregon Light and Power Co., following 23 years of work in public utility administration.

National Starch

Opening of National Starch's Alexander Research Laboratory at Plainfield, N. J., marks the latest step in the companys two million dollar resin expansion program. The laboratory was named after Alexander Alexander, founder of the company in 1895. From a small adhesives plant in New York City, the company has expanded to four plants in the U.S.A., two in Canada, one in England, and one in Holland.

The new Alexander Research Laboratory of National Starch Products, Inc., in Plainfield, N. J.

LeRoy A. Grettum, Pusey, & Jones Corp.

Carl E. Schmitz, Crane Packing Co.

Crane Packing

Carl E. Schmitz has been appointed Vice-President in Charge of Sales for Crane Packing Co., Chicago, Ill. He was formerly Director of Engineering and President of the American Society of Lubricating Engineers. In addition, the following division sales managers were appointed: E. H. Stubenranch, Mechanical Packings; Stephen Hawxhurst, Molded Teflon Products; Harry I. Sole, Lapmaster; V. E. Vorhees, Mechanical Seals; and Stillman Segar, Plastic Lead Seals.

Impco

The Improved Paper Machinery Corp. stockholders voted at their annual meeting held in Portland, Me., January 29, for the sake of simplicity and convenience to everybody, that the name should be changed to Improved Machinery, Inc.

The business was started in 1890 under the name of Improved Paper Machinery Co. The ownership changed hands in 1929, and to differentiate the former company from the new corporation, the name was changed to Improved Paper Machinery Corp.

The trade name "IMPCO" will continue on all the products, but in the intervening years development work has continued with numerous additions to the line of machinery available, including the beginning of a Plastic Molding Machinery Div. in 1945. Like the plastic machinery, as well as some others such as that for preparation of viscose, not all of the company's equipment is for paper. In fact, most of it, such as filters, screens, deckers, agitators, etc., are primarily for *pulp mill* use. It was, therefore, felt that the new name would be much more representative.

The corporation officers remain the same, including Walter L. Barker, Chairman of the Board; John P. Rich, President; Elmer R. Burling, Executive Vice-President; John H. Noble, Vice-President; Kent W. Smith, Treasurer; Ralph P. Emerson, Secretary, Allan M. Barker, Assistant Treasurer; who are also Directors; and Normal I. Foster, Comptroller.

Sales and service offices are located throughout the United States: John H. Noble, Room 1355, 230 Park Ave., New York City; J. P. Rubush and W. E. Osborn, Advance Building, Seattle, Wash.; J. W. Marcille, 1901 E. Brainert St., Pensacola, Fla.; Lamar M. Murray, 123 Allegheny Rd., Forest Hills, Savannah, Ga.; J. K. Perkins, 4214 Park Ave., Richmond, Va.; F. L. Putnam, 5 Cunningham Ave., Glens Falls, New York; H. R. Ahrens, 1420 S. Memorial Dr., Appleton, Wis.

The Agitation Sales Div. is headed by Arthur L. Whiteside.

The Plastic Molding Machinery Div. is represented by George W. Whitehead, Sales Manager. Other representatives of this division are: Frank Z. Bailey, 41 Riverview Ave., Groton, Conn.; Lyle V. Burford, 1722 W. 109th Place, Los Angeles, Calif.; George G. Doughty, 3924 Washington St.,

Downers Grove, Ill.; Hibbert W. Moss, Room 1355, 230 Park Ave., New York City.

Main engineering sales offices for both plastic, pulp mill equipment, and other lines are at the company's plant, P. O. Box 503, Nashua, N. H.

FAWICK

R. S. Huxtable, President of the Federal Fawick Corp., has announced five new executive appointments for the Fawick Airflex Div. of the corporation. Fawick Airflex, located in Cleveland, manufactures industrial clutches and brakes. John V. Eakin, who has been with the company since 1943, has been appointed Assistant General Manager. He was formerly Sales Manager and Southwestern District

Manager. Clement Reeves has been named Sales Manager to succeed Mr. Eakin. Reeves joined Fawick in 1945 and has been in charge of sales to manufacturers of earth moving and construction equipment. Working with Mr. Reeves will be K. R. Spelman, who becomes Assistant Sales Manager. Mr. Spelman has been a Sales Engineer since he went with Fawick in 1945. J. S. Walsh, formerly Chief Engineer and with the company since 1944, becomes Director of Engineering and Service. W. A. Franck, who was Design and Development Engineer, and with the company since 1943, now becomes Chief Engineer. According to Mr. Huxtable, these appointments were made to provide Fawick with a more effective management team in anticipation of increased sales activity. These promotions were also designed to coordinate operations of the division with the corporation formed by the recent merger of the Fawick Airflex Co. and the Federal Motor Truck Co. of Detroit.

DOWNINGTOWN

Downingtown Manufacturing Co., Downingtown, Pa., recently obtained a contract to manufacture a fourdrinier machine purchased by Valmetefor Vietsiluoto O.Y. of Finland. The machine is to be the centilevered type with parts subject to corrosion made of stainless steel. In this respect, the machine is similar to the one Downingtown designed, built and installed at Sonoco Products Corp. in North Carolina. The new machine for Finland is scheduled to be completed by December, 1953. The contract for the machine was placed through U. S. Wallboard Machinery Corp. of New York, Export Engineering Department of Downingtown Manufacturing Co.

James M. Thornton, recently Chief Engineer in Charge of Development for Downingtown, is now associated with John V. Roslund who represents Downingtown on the Pacific Coast.

OBITUARY

Frederick Haviland MacLaren

Frederick H. MacLaren, Group Leader in Wax and Asphalt Research for the Standard Oil Co. (Indiana), died recently at Munster, Ind. Mr. MacLaren was born in Bennington, Vt., on Sept. 14, 1902, and graduated as a chemical engineer from Ohio State University in 1925. He was engaged in research work for the Standard Oil Co. at Whiting, Ind., since graduation, dealing with problems concerning wax coating and laminating of food packaging papers. He was a member of the Technical Association of the Pulp and Paper Industry.

RECENT BOOKS

Phillips' Paper Trade Directory of the World—1953. S. C. Phillips & Co., Graham House, 3 Tudor Street, London, E. C. 4, England. Cloth, 5 × 8, 865 pages. 39/6 *d.*

The 1953 Phillips' Directory gives current information concerning paper, pulp, and board mills throughout the world, with particular emphasis on British mills, giving addresses, number and size of machines, capacity, etc. Makes of paper and board are classified. A glossary of paper industry terms in six languages is appended. The growing interest in foreign trade makes this annual directory of considerable value.

Ink and Paper in the Printing Processes. By Andries Voet, Director of Ink Research, J. M. Huber Corp. Interscience Publishers, New York, 1952. Cloth, 6 × 9, 213 pages. $5.90.

This volume is intended as an introduction to the physics and chemistry of ink and its interaction with paper in the major printing processes. A special effort is made to indicate some of the scientific investigations on the subject made in recent years that are not generally known to students in the graphic arts.

Included in the contents are such subjects as the function of ink, measurement of ink flow, separation of ink films, microscopy of half-tone printing, uniformity of films, penetration of ink into paper, ink transfer, picking of paper, offset, physical drying of ink, etc. The reputation of the author himself is sufficient recommendation for the book.

Control of Electric Motors. 3rd Ed. By Paisley B. Harwood, Vice-President in Charge of Engineering, Cutler-Hammer, Inc. John Wiley & Sons, New York, 1951. Cloth, 6 × 9, 538 pages. $7.50.

The third edition is a complete revision of this well-known text on controllers. It deals with such subjects as wiring diagrams, construction of control apparatus, automatic regulating systems, two-motor drives, the squirrel-cage, momo-rotor, single-phase and synchronous motors; adjustable-voltage controllers, resistors, etc.

LOCAL SECTION ACTIVITIES

Reports of Meetings, Personnel, and Events

Delaware Valley

The January meeting of the Delaware Valley Section was held at the Engineers Club on Thursday evening, January 22, 1953. One hundred and thirty-seven members and guests attended the dinner and evening program.

Harold Brill, Chairman of the Section, opened the meeting with several announcements. The E. J. Albert Award competition will be held on May 28, and all men interested in entering papers should notify A. L. Bixler, Riegel Paper Corp., Milford, N. J., or John Macadam, National Vulcanized Fibre Co., Wilmington, Del., as soon as possible. Mr. Brill reminded the group that an evening course in "Pulping and Papermaking" will be taught again this Winter at St. Joseph's College by A. J. Haug. The first lecture was given Friday, February 6. All TAPPI members who favor plans to hold an evening dance next June were asked to signify their interest by returning the cards enclosed in the last monthly news letter.

Mr. Brill then turned the meeting over to Frank Lovegren, Program Chairman of the Section, who in turn introduced Ward Harrison, Vice-President of Riegel Paper Corp., Milford, N. J., and moderator for the evening's panel discussion. The subject was "Development of Paper Properties." Mr. Harrison opened the program by introducing the members of his panel. They were: C. M. Connor, Vice-President of W. C. Hamilton and Sons, Miquon, Pa., A. J. Haug, Paper Mill Superintendent, Scott Paper Co., Chester, Pa., Elmer Mitchell, Superintendent, McDowell Paper Mill, Glassine Paper Co., Manayunk, Pa., W. D. Rice, in Charge of Chemical Engineering, P. H. Glatfelter Co., Spring Grove, Pa., and J. P. Weidner, Technical Superintendent, Container Corp. of America, Manayunk, Pa.

Mr. Harrison outlined the subject to be discussed, and a portion of his comments are presented below:

"Not too long ago papermaking was truly an art. The papermaker jealously guarded the secrets he knew about the development of paper properties, many of which he had determined for himself by trial and error. Some of us can remember papermaking of this sort. I am happy to observe that technical men have taken over the industry, and knowledge based on fact is being built up and disseminated at an ever increasing rate. The TAPPI organization has been a great factor in furthering this trend.

"Of course, there are more variables that affect the development of paper properties than we can consider tonight. We know some of the ways that paper properties can be developed, but we also know that much more can be learned. In this humble position we come before you to present what might well be considered an oversimplified version of the development of paper properties. We have done this with some misgiving, because unusual circumstances can always be found which will contradict us. The following statements are made in the hope that they will provoke a lively discussion.

"We believe that outside of the basic paper properties of basis-weight and moisture content, we can consider the development of most of the important aspects of paper under four headings: (1) furnish, (2) beating, (3) formation, and (4) sheet density.

"These aspects are so important that it is impossible to decide which should be discussed first. However, since no paper property can be considered until the furnish is known, we will consider that subject first.

Furnish: The fiber part of the furnish can be varied almost infinitely. In the past we have always considered fiber to be organic filaments, but today even inorganic filaments are finding their way into paper. We do not have the time to go into detail tonight on fiber dimensions, but we should make the following general statements:

"1. Long fiber furnishes will usually make higher testing paper. It does not form as well as a shorter fiber and in some cases this might result in lower strength characteristics than obtained with a short fibered sheet which has been well closed.

"2. Thick fibers tend to form poorly. For example, a sheet of hardwood fibers will form much better than one of softwood fibers, all other things being equal.

"3. Combinations of short hardwood and long softwood fibers make strong, well-closed sheets.

"The furnish for any sheet generally includes materials other than fibers. Such materials might be fillers, acids, and alkalies for pH control, resins and elastomers, colors, defoamers, softening agents, and a formidable list of other additives.

"When fillers are added to the furnish, they always decrease the strength and increase the softness of the paper. While filler is usually used to brighten a sheet, improve its surface and opacity, or make it less expensive, this is not always the case. Special fillers may be added to impart a given color, reduce static electricity, or control the porosity of the sheet.

"Sizing affects the properties of paper in many ways. We are all familiar with the use of rosin size to create hold-up of ink. Wax sizes are primarily used to repel water solutions. Other chemicals like glue, casein, or alpha protein are added to sizing solutions to improve waterproofness, scuff resistance, bloodproofness, and many other special properties.

"Alum of course is used to set or precipitate sizes, but it can also be added to increase paper hardness.

"We could spend the rest of the evening talking about other additives, but we must move along to the second important factor in developing paper properties.

"*Beating:* After choosing the furnish for a sheet of paper, we will next consider the proper working of it in beaters or refiners. As we beat or refine a given furnish, we increase density, burst, tensile, and stiffness. At the same time tear, opacity, and dimensional stability are decreased. The more we treat fibers in such equipment, the more we shorten them and increase their bonding ability.

"The beating and refining operations can be handled in many ways to produce a wide variety of results. For example, we can carry out the operation to get predominately cutting, or we can control it to get mostly hydration and fibrillation. Most beating operations give a combination of these effects. When thick stock is fed to a jordan or high-speed refiner, the action will be primarily hydrating rather than cutting. The opposite is true when thin stock is fed to slow-speed equipment. In high-speed equipment the size of the bar is relatively unimportant. In slow-speed jordans, however, wide bars give more hydration and narrow bars give more cuttings.

"It should be remembered that all beating and refining operations increase the surface area of the fiber and thus the possible bonding area. This bonding area is a linear function of beating time, but most paper properties are curvilinear.

"*Formation:* When we talk about good formation, we mean a sheet is homogeneous. Good formation is obtained by:

"1. Well-beaten stock (flexible long fibers along with cut fines to fill in the voids).
"2. Enough water to separate the fibers and thus eliminate clots.
"3. No disruption of the sheet during the forming and subsequent dewatering steps.

"When everything else is equal, good formation gives the best sheet appearance, printing surface, and almost always the best strength. It is possible of course to make a 'wild' sheet of long, well-hydrated fibers that will be stronger than a well formed, short fibered sheet of the same weight. But there is great virtue in a well-formed sheet, and we are always striving for it within the practical limits of economy.

"Why then are papers made 'wild' sometimes? Generally because a sheet can be made faster if the water rate is kept down. Grocery bag paper is a good example. Such a sheet is made from unbleached kraft and generally from long, thick fibers, where there is plenty of tear available even in poorly formed sheets.

"High water rate on a machine (i.e., low headbox consistency) is very important in producing good formation, as are slow speeds, long wires, and good shake. Even with these it is possible to ruin good formation by crushing at any point on the wire or in the press section.

"*Sheet Density:* In the opinion of some people density is the most important property of paper. We can control the density of a sheet not only by means of the furnish and beating but also by pressing at various stages on the paper machine. The development of paper properties can best be discussed by considering separately the positions on the machine where density can be changed.

"A wove or plain dandy roll can be adjusted to improve formation on the wire. This is the mildest form of wet pressing. When used properly it will get the sheet in shape to develop the maximum bonding strength inherent in the furnish. Lump breaker rolls riding on the couch do considerable pressing. By compacting the wet sheet such a roll will decrease the number of wet end breaks on many grades of paper.

"Wet pressing with baby presses on the felts imparts smoothness to the sheet and removes enough water so that greater pressures later will not crush the sheet. The normal wet pressing with regular presses develops more smoothness, higher density, and closer meshing of the fibers. As a result we obtain higher folding endurance, burst, tensile, and stiffness tests on the finished paper.

"Smoothing presses before drying do exactly what their name implies and augment the wet pressing effects obtained earlier.

"Pressing during drying can be done with bare rolls. The closer to the wet end this is done, the more effects of wet pressing we get as compared to dry pressing. Wet pressing changes the internal characteristics of a sheet, while dry pressing changes to a much more marked degree the external properties.

"Pressing after drying can be done on machine or supercalenders. Such pressing increases the surface smoothness of the paper greatly but has little effect on sheet strength."

Panel Discussion

After Mr. Harrison's comments the meeting was thrown open to questions from the floor. The discussion which followed is presented in part below. Responses were made by members of the panel:

Q. Is it common experience that paper loses strength as Summer approaches, and if so why?

A. That is the usual experience. Strength properties of a sheet depend in part on the uniformity of formation. As the machine water system warms up in the Summer, the viscosity of the water drops, the paper is formed so early on the wire that it cannot be properly closed up, and weak spots result.

A. As viscosity increases there is more chance to produce a uniform distribution of fibers on the wire. In the Summer every effort is made to keep the water temperature down. We cut out all condensate water. Hot water will help you to run the machine at high speeds, but then you must refine well and use long fibers to offset faster setting on the wire.

Q. What effect do Summer temperatures have on beating?

A. On rag stock Gilbertson found that hot beating dropped sheet strength, and that cold water helped. We have run cold water on the hood of the beater, but that didn't help.

A. On wood fibers the colder the water, the faster the beating, but the temperature had little effect on sheet strength. More greaseproofness can be developed by running the beater hot.

Q. If Summer temperatures affect stock viscosity in the headbox, why not change headbox consistency in the Summer to give the same headbox freeness as in the Winter?

A. Changing headbox consistency that way would probably make it impossible to maintain the normal balance of water, fibers, and fines in the machine system.

Q. Does filler retention increase with beating?

A. That depends upon the filler you use. Our experience indicates that a large size calcium carbonate filler is retained best when added at the machine. A fine filler, like titanium dioxide, is retained better if it is ground well into the fiber in the beater.

Q. Laboratory beater data show that mullen passes through a maximum. In commercial operation do you ever go past that point?

A. In making book paper we do not keep it in our beaters long enough to reach that point.

A. In tissue manufacture we are way off the graph to the left.

Q. How about the maximum point on the tear graph? Do you go past that?

A. That tear maximum is hard to find. It is observed most frequently when long, woolly fibers are beaten, and for many stocks or in many types of refiners you cannot pick up the maximum at all. Most papermaking is done between the maximum tear and maximum mullen on the beating curve.

Q. We know that maximum sheet strength requires separation of the fibers and the elimination of clots in the headbox. What is the most effective headbox consistency for good separation without overloading the machine system with too much water?

A. That depends entirely on what you are making. You want much water for good formation, but you do not want the sheet running so wet that you have to slow the machine down. We run only enough water to get a good balance of sheet tests and satisfy product quality standards.

Q. Do fillers always improve sheet formation?

A. Within limits yes, but that is a hard one to answer categorically. Anything that fills up the sheet's interstices should help formation.

A. We're accused of ruining formation sometimes by the addition of titanium dioxide. What actually happens is that we are adding an opaque filler which concentrates in fiber clots. That in itself does not make poor formation, but it makes poor formation more apparent.

Q. For a given furnish how can you improve flatness and reduce curl?

A. There is no one condition that produces curl and no one remedy to cure it. Adjustments may be necessary all the way from the slice to the calenders. Changing the tension of the draws or the position of the slice may help, or shutting off the last few driers to run a damper sheet may be the answer.

A. We are using our drier facilities to the hilt and cannot afford to shut any off. We believe that curl is due to stresses set up in the sheet when it hits the first few driers. The shock of this high temperature puts stresses in the sheet, and these produce curl when the reel is sheeted or run through a printing press. So we try to dry at low and graduated temperatures.

Q. What happens in the seasoning of paper? You hear old paper men say that the workability improves on seasoning. Is that due to an evening out of the differences in moisture content or to a relieving of these internal stresses you mentioned?

A. Both points are important. The seasoning of paper is an age-old practice. We get the same beneficial effects today by conditioning individual sheets or thin stacks of the sheets.

Q. Does the freezing and thawing of paper hurt its properties?

A. When groundwood or sulphite pulp is frozen and then thawed, there is no loss in strength, but pulp may behave differently from paper.

A. I do not believe so. When deep freeze paper is tested before freezing and after thawing, there is no significant difference in strength.

Q. Does wet lap pulp give you better strength and greaseproofness than dry pulp?

A. Freight rates are obviously higher, but we make better glassine from wet lap pulp. When you dry pulp beyond 70% consistency you lose mullen and tensile.

A. An unbleached sulphite dry lap gave 10 to 15% less mullen than the same pulp shipped wet.

A. We found no difference in the strengths of a semichemical pulp dried to 50 and 70% consistencies. In going from 70 to 90%, however, mullen dropped off and tear appeared to go up.

A. The temperature of drying is important in that respect. We have found that a Minton vacuum drier, which operates at low temperature, produced a stronger pulp than conventional high-temperature pulp driers.

Q. What effect does soaking a pulp before beating have on its strength properties?

A. Tough pulps are easier to handle after soaking, and if you have soaking capacity that is a good way to save horsepower.

Q. Glassine makers have found that on week-end shutdowns calendered stock held in storage will have lost strength by Monday. This is of course is soaking after refining, and the condition could be corrected by adding alum to the stock on Monday.

Q. What are the operating extremes for headbox consistency?

A. I've heard of consistencies as low as 0.03% and an upper limit of 1.1%.

Q. Is a plain wire harder to drain through than a twill wire of the same mesh and open area?

A. Drainage is greater on a twill or semitwill weave. That has been shown in the lab and commercially. A plain weave with 24% open area is equivalent in drainage rate to a twill weave with an open area of 20%.

Q. How much can you expect to increase sheet strength by additional wet pressing?

A. Wet pressing is important in this respect, although not so much so as furnish and beating. The increase in strength is related directly though not linearly to the increase in solid fraction.

Q. In the packaging of deep frozen foods what properties are needed for the packaging?

A. It must be moistureproof to keep the food moist, strong so that bones cannot puncture the sheet, moldable at the low temperatures, and capable of stripping easily from the frozen food.

P. E. Nethercut, *Secretary*

Kalamazoo Valley

Three hundred and fifty individuals attended the joint meeting of the Kalamazoo Valley Section and the Michigan Division of the Superintendents Association held at the Hotel Harris, Kalamazoo, Mich., on January 15, 1953. Maxwell D. Bardeen of the Lee Paper Co. presided as toastmaster. A. T. Luey of the Sutherland Paper Co. presided as chairman.

The principal speaker was A. Newell Rumpf, Vice-President of the Harris Trust and Savings Bank, Chicago, Ill. Mr. Rumpf's talk on "Some Economic Aspects of the Pulp and Paper Industry" follows:

Mr. Chairman, members of the Kalamazoo Valley Section of TAPPI, the Michigan Division of the American Pulp and Paper Mill Superintendents Association, and guests:

I am delighted to have this opportunity to speak to you about the paper industry. As you are well aware, it occupies sixth position in value of our national products. Yet, until quite recently, it received scant attention from the financial analysts and others, outside of those closely identified with its day-to-day activities. This may be accounted for on at least two counts: first, until World War II, the industry had been able to keep up with demand and there was no problem on the part of consumers to have their wants supplied; and, second, the basic complexity of the industry itself. I know of no other industry which has so many diversified uses for its products and so many factors to deal with from the raw material to the finished product. Due to the diversity of products, no general formula can be applied to it, which makes it difficult to explain to those who have not had long and continuing association with it. This probably has discouraged a study of the financial and economic aspects of this very basic industry. Accordingly, it is my hope tonight to review briefly some of the underlying economic factors which exist in the primary industry to the end that you yourself may be inspired by the vastness of the business in which you are engaged.

It has been my pleasure to follow your industry through being identified with bank financing of a good many mills in the central States area. Our institution has made loans to many of your companies represented here tonight as well as others, particularly those in the Midwest.

Primarily you gentlemen are interested in the technical aspects of the product. A successful technical man, however, must by necessity associate himself with broader elements of the industry if he is to make a complete contribution to his company and to the industry as a whole. The world is dependent on the products which result from your work; but, in order to bring about its complete fruition, there must be a flow of money and credit to your plant. The results determine the credit which will be available to your concerns and without credit you will be unable to produce and market your products.

It is hoped that a few of my comments this evening will result in your taking an increasing interest in the administrative affairs of your respective companies. While this may necessitate a study required to understand, interpret, and evaluate balance sheets and profit and loss statements, it is my firm conviction that such time spent will be extremely worth while.

Prior to fairly recent times, each individual mill went its own independent way and it was difficult for the investment analyst to secure an over-all picture of the industry. That the need was present is indicated by the result. Now we find many publications and studies on a continuing basis which are of great value in determining not only the position of an individual company but more particularly its relationship to the industry as a whole. There are numerous publications listing financial data on the paper industry and the following is representative but by no means complete:

1. Federal Reserve Board Index.
2. Census of Manufacturers—U. S. Department of Commerce.
3. U. S. Manufacturing Corporations—Federal Trade Commission and Securities and Exchange Commission.
4. Various publications of the American Paper and Pulp Association, such as its monthly statistical summary, capital and income surveys and other similar studies.

A comparison of the data of the paper industry with the overall production index published by the Federal Reserve Board shows where we have been and suggests trends which may lie in the future. Through an intelligent study of these available tools, a good deal of the guesswork is removed in the determination of the course for future action.

A dozen years ago, when I started observing your industry at close hand, I was told that it was regarded pretty much in the "prince and pauper" classification. However, over the years I have come to more fully recognize the vast economic improvements in the industry since its depression lows and question actually whether it should ever have been classified as a feast or famine business. Whatever its difficulties may have been in the past they were, I believe, more attributable to its mishandling of its corporate affairs than to external factors. A sincere study reveals strong fundamental characteristics principally accounted for by its close affiliation with consumer goods. Accordingly, if soundly financed, a well-ordained growth trend is in order. Certainly, in the last decade, it has been a profitable investment for the owners.

Let us look for a moment at the past. During the early depression years, the industry experienced difficult times. As suggested previously, a large portion of this resulted from within the industry rather than from outside sources. Grade shifting appears to be an inherent characteristic and it was to be expected that mills finding themselves without orders in high profit items shifted downward in order to capture part of the market formerly dominated by competitors. Obviously this step was taken in an effort to cover overhead and burden. Downward pressure brought about the bankruptcy of marginal mills. With price cutting, irrespective of demand, it was no surprise to find a chaotic condition existing in the industry as a whole.

It is well known to you all that the industry is characterized by a large fixed plant investment and resultant heavy overhead charges. Profits vary widely on relatively small fluctuations in operating rates. It should not be overlooked that many companies, 20 years ago, had heavy capitalizations with large debts and fixed charges which were burdensome when sales contracted. The largest unit in the industry, for example, had almost $200,000,000 of long-term debt and preferred stock at the end of 1937. It is interesting to note that its long-term debt has now been entirely eliminated and there is only a fourth of its preferred stock ($23,000,000) ahead of common equity today. Meanwhile, its sales have increased fivefold.

During the thirties, yearly operating rates ranged from 58 to 83% with an average of 72% of capacity for those ten depressed years—actually, considering other industry classifications, a relatively good showing.

The period of World War II is familiar to all of us, with production materially behind demand and a belated recognition on the part of government as to the essentiality of the product. It was not unexpected that, with shortages of raw materials all along the line, production ran behind capacity. The trend of production stabilized at around 17,500,000 tons during the war period, but shortly thereafter resumed the upward trend which started in the thirties.

The past 20 years have witnessed a more or less upward trend in paper production in the U. S.—1952 production at an early estimated 24½ million tons, compares with 8 million in 1932, 12.8 million in 1937, and 19.3 million in 1946. Hence, for the last ten years, what with capacity expansions and increased demands, operating rates until last year were at virtually capacity levels. At the same time, these high operating rates afforded a favorable

internal leverage factor for the industry and net profits rose at an accelerated rate held down only by price ceilings and taxes. This enabled many companies to reduce substantially their funded debts and fixed charges while undergoing a substantial growth in total assets.

The following statistics reveal a few of the financial changes which have taken place since 1939:

	1939	1946	1951
Total assets (billions)	$2.36	$3.28	$6.60
Long-term debt (millions)	N.A.	N.A.	$885
Net worth (billions)	$1.70	$2.42	$4.40
Net sales (billions)	$1.45	$3.55	$7.22
Federal taxes (millions)	$18	$208	$982
Net earnings after taxes (millions)	$84	$302	$577
Per cent of net earnings to net worth	5.0%	12.4%	13.3%
Per cent of net earnings to sales	5.8%	8.5%	8.0%

N.A.—not available
Source: American Paper & Pulp Association.

Per capita consumption of paper has shown a most interesting use trend. Even you gentlemen, who make your living in the pulp and paper industry, are surprised at the individual annual consumption which is reliably reported at 384 lb. in 1951. In 1903, which I would judge is close to the average birth date of your group, the figure stood at about 65 lb., and has risen almost without interruption over the half century. Some years ago, The *Paper Trade Journal* carried on its title page the statement: "The consumption of paper is the measure of a people's culture." Certainly this holds true in America where our usage is more than double that of any other nation with the exception of Canada.

We are all aware of a change in supply and demand which existed during 1952. From 1940 until last year we were in a dream market where the only limitations were those of raw materials, price ceilings, and taxes. Accordingly, it was not surprising to hear a wail from some sections of the paper industry. A few statistics may give proof that the cries originated in the financial breadbasket.

One of the largest manufacturers of kraft containers saw its sales volume fall from $55,392,000 in the first nine months (only figures available at this time) to $38,192,000 or a decline of 31%. Its profits after taxes for the same period were down 59%. A generally well-recognized manufacturer of white papers showed a decline of 14% in sales over the same period and a 28% lower profit after taxes. The largest unit registered a decline in sales of only 1.2% but its net profit declined 14%. In fact, a study of 14 companies whose stock is listed and fairly represent a cross section of the industry reveals that only one company recorded higher sales for the nine months ended September 30, and all of them had lower profits compared with the same 1951 period.

Over all, the estimates of the American Paper and Pulp Association on the production of paper, to rated capacity for the full year 1952 was around 90.6% as against 98.0% for 1951. In the case of paperboard, the ratio was approximately 86% as compared with 94% in 1951.

No group appears to have been immune to a decline with the exception of newsprint, which still represents a small segment of total U. S. production. As a matter of fact, a price increase was recorded in this product while prices as a whole declined in most other lines.

The reasons for the decline are largely known to all. At the time of Korea, the shortages of World War II were fresh in the minds of all paper consumers, with the result that a rush of buying was instituted. A large segment of this order-placing was of a hoarding nature. When it became apparent that paper was not in short supply, and when inventories generally were pyramided at the manufacturing and distributing level, a wave of cancellations and retrenchment took place. The first to feel the change were the paperboard producers. This was in spite of a near record peak of over-all manufacturing. Next to feel the reduction in demand were the tissue mills—indicating that, in spite of high national income, the pipe lines all along the line were filled. I am reminded of a small bank with 27 employees which I visited last March. In the basement I noted 12 cases of toilet tissue taking up valuable space. I don't know the rate of consumption of this group, but I am inclined to feel that more than one year's supply was on hand unless they planned to use it in a shortage as an inducement to get new accounts. Other fields such as book and bonds felt the effect of lack of orders as the year progressed, but to an apparent lesser degree. It should be recorded that late in 1952 renewed buying interest took place so that at the year end, demand in the industry was not far out of balance with supply.

If I read the history of your industry correctly, the dip was either considered by most manufacturers to be of short duration or the industry is much better financed. Formerly, price cutting would have been freely instituted but, outside of a few instances prices held firm in spite of lowering sales volume.

It is to be noted that in recent months the gap between production and demand is closing. Based on industry contacts, I believe that the recent excess inventories in the hands of paper users have been liquidated and look for a renewal of the basic strong demand for paper products. A favorable factor is the recent revival in activity in paper-consuming industries such as the textiles. It is quite apparent that there was over-buying and over-production in the first half of 1951 and under-buying and under-production in the first half of 1952. This situation was mainly in the more volatile paperboard division.

The decline last year in Canadian and Scandinavian pulp prices made good press copy. However, the truth of the matter is that these prices were on the high side a year ago. For example, Scandinavian bleached sulphite pulp was at $250–$300 a ton in early 1951 and Canadian pulp was $160–$175 a ton as compared to $145 for domestic pulp. Now both of these pulps have come down to meet the more realistic (and consistent) domestic price. Over-all paper and board prices now appear in line with other commodity prices, which also generally declined during the year. For example, as compared with the Bureau of Labor Statistics Wholesale Commodity Price Index of 110.7 for November, 1952 (1947–49—100), the index for paper (exclusive of newsprint) was 122.9, paperboard was 124.8.

So much for yesterday and today. What of tomorrow in the paper industry? I claim no infallible crystal ball. Although I am a member of the fraternity of optimists who would rather be wrong that pessimists who are right, there are three factors by no means exclusive to the paper industry which give concern to the banker when viewing the future. I refer to taxes, cost of replacement of machinery, and expansion.

The impact of Federal income taxes on the industry acquired terrific force in 1951. At their peak during World War II, they amounted to 9.1% of sales, 11.6% of net worth, and 8.3% of total assets. In 1951 they were 13.1% of sales, 21.6% of net worth, and 14.4% of total assets. When income and profit taxes take over 21% of net worth against 5.9% for dividends and when these taxes take more dollars out of the paper industry than was paid in wages, it would appear that the industry is close to being bled white.

As is well known, a high investment per ton of output is involved in the industry. The APPA indicates a property account of $3076 million at the end of 1951 with 212,000 workers. This results in a $15,000 investment per employee. Total assets per employee approximate $31,100, while the sales per employee amounted to $34,100. With the high cost of new equipment to increase productivity, normal depreciation standards are insufficient and must be met out of new capital. This high cost restricts new entrants to the field.

Planned new capacity through 1955 is 2,304,000 tons over December, 1951. Of this—1,033,000 tons is paper and the balance, board. This represents a 12 and 15% increase, respectively, over 1950 to a total of 27,750,000 tons. Some of this may be canceled or delayed—but one is prone to wonder if it can all be put to profitable use as it comes into production. Surely, if our income system cracks, there will be pressure to move products by present lower-cost producers.

The paper industry is not only one of the oldest but one of the largest—ranging as it does in sixth position among the larger businesses in our country. Primary production in 1951 was in excess of $6 billion. Someone has said that it is the third most used product in America today, following water and milk.

America, with 6% of the world's population, consumes 68% of the world's production of paper products. It produces 58% of the total of paper and paperboard. It is by no means a static industry!

A study made by the Federal Trade Commission reveals that 103 paper and allied products corporations showed the following rate of return (after taxes) on stockholder investment: 9.6% in 1940, 21.1% in 1947, 18.2% in 1948, 12.1% in 1949, 16.1% in 1950 and 18.3% in 1951. Only industrial chemicals, office and store machines, motor vehicles, electrical machinery and equipment businesses did better. It would appear that the industry and its stockholders are in good company.

During the past ten years the paper industry has come to be considered by the investing public as an industry in which satisfactory investments can be made. Like all other industries, the paper industry offers investment opportunities that may vary company by company, but taking the industry as a whole, its record will bear analysis for years back as well as during the post-war periods.

The paper industry earnings record, taken as an industry, will stand up with "all industry" earnings in depression as in prosperity, for in fact, the paper industry has operated more steadily in depression periods than most industries. In the low year of

H. Mimms, Kalamazoo Paper Co.; H. W. Hartman, Chairman, Michigan Div. Supts. Assoc.; M. D. Bardeen, Lee Paper Co.; A. T. Luey, Sutherland Paper Co.; A. Newell Rumpf, Harris Trust & Savings Bank; R. H. Hurst, Kalamazoo Vegetable Parchment Co.; W. H. Brydges, Trustee, Supts. Assoc.; and G. K. Singletary, President, Supts. Assoc.

the great depression (1932), the paper industry was operating at 80% of capacity, while steel was almost flat on its back below 20% and banks dependent upon the automobile industry were in distress.

The paper industry is, of course, a service industry, and it therefore is dependent upon general business activity for its own activity. But it must be remembered that whatever business is done demands the use of paper as a necessity. *Business cannot be done without paper!*

If the prophets in government and private industry are right, the United States is going to be a mighty big and zestful place to live in in 1975. Population will number about 193 million, up 42 million. All this will mean far more need for paper products.

There is another factor which people usually overlook, namely, there is presently no economic substitute for paper or paperboard. On the contrary, paper and paperboard are the economic substitutes for wood, tin plate, glass, metals, textiles, and a host of other raw materials. Take the frozen food industry as an example. Clark Everest of Marathon Corp., in a recent talk to some of his sales organization, made the remark that within five to ten years a June bride would have to go home to mother to find out about the fine art of manipulating a can opener. This may be a bit exaggerated, but in the main it is true. People are living out of refrigerators with a limited number of cubic feet capacity. The tendency is toward rectangular packages; round containers take up too much room. Airlines led the way with prepared meals which were prepackaged and practically all in paper, and now some railroads are following this procedure for dining car service. It is probable that this will be extended to thousands of homes. This all means the use of more paper and paperboard in many divisions—from the papers used for advertising, packaging, wrapping, and paper cups, to the corrugated boxes in which the products are delivered.

Several industries have experienced trying times in recent years. I refer specifically to textile and television. Both have seen their sales fall to low points over an extended period of months. Each has been bolstered by an over-all prosperity, to the end that today their operations are close to normal. Fortunately the depression in these fields did not spread to others. It may be recorded that a somewhat similar depression existed in the paper industry in 1952, although its low point, in terms of rate of production to capacity, was only 73.3% (July). If recessions in single or small groups of industries occur, the impetus given by other industries operating at near peak production rather promptly provides a correction.

There is considerable talk these days on the inevitable collapse of business. We've been hearing this old and oft-repeated story ever since the beginning of World War II. And the impending day of doom has been many times postponed. First it was the end of the war, then the end of the postwar buying boom. Now it's to come, according to many economists, when defense spending tapers off.

To expect a major recession, after defense production diminishes is to assume that government spending is the source of all momentum in the economy and that there is nothing to take its place. Defense spending has opened up new resources and manufacturing and has created new and permanent sources of prosperity. Our base metals, toolmaking, even textiles, have been affected. But defense does not dominate the country's business life. It is part of it, but the main steam is from expansion for larger home and foreign markets. It does not make or break us. When and if the energy devoted to defense can be relaxed, there will still be plenty of people with expanding tastes to eat good food, to build good houses and furnish them, and to invest in the future. And with lower taxes possible, they will be left with more money to spend.

We should bear in mind that at the height of World War II only 5% of our paper and board production was for direct defense. With the added capacity since that time, probably only 2½% is now directed to the defense effort. While important as this may be, the paper industry can eliminate it altogether and still make a respectable profit showing.

Obviously there are continual shifts in the prosperity of industries and of regions. As we return to more competitive conditions, these are more marked. But we shouldn't let our views be colored by the "inevitable" collapse theory. Every structural development, change in markets, fluctuation in prices, decline in stocks, every ripple on the surface is certainly not a signal for running for the lifeboats.

There is not a single industrial or commercial activity which is not dependent on paper. In fact, from "birth certificate to death certificate" every child born in this country is a potential customer for some kind of paper or paper product.

Pacific

The Pacific Section met in Seattle, Wash., on Jan. 13, 1953. This meeting included a visit to the new Medical Building of the University of Washington at 11:00 a.m. The Technical Meeting was held at 2:00 p.m. in Bagley Hall on the University campus.

The group attended a dinner at 6:30 p.m. at the Edmond Meany Hotel, following which P. C. Cross, Executive Officer of the Dept. of Chemistry and Chemical Engineering, spoke on the subject of "Explosion Phenomena."

This meeting was attended by 124 individuals. Svarre Hazelquist presided as Chairman of the Section and E. Gray King was in charge of the meeting. Elmer Christoferson had charge of local arrangements. The theme of the meeting was "Routine Analytical Methods."

Following are summaries of the papers presented at this meeting.

Multistage Separation of Substances Between Two Immiscible Liquids. Presented by V. F. Felicetta and Joseph L. McCarthy, Pulp Mills Research Dept. of Chemistry and Chemical Engineering, University of Washington, Seattle 5, Wash.

If two or more substances are partitioned differently between two phases, then it is possible to separate the substances from one another to a degree which depends upon the value of the partition coefficients, the ratio between the coefficients of the two substances, the volume ratio of the phases, the number of available stages, and the number of transfers applied.

On this basis a 100-stage automatic countercurrent distribution machine has been built in this laboratory for multistage separation of solutes.

A description is given of this machine which is similar to one described by Craig (*Anal. Chem.* 23: 1236 (1951)). Equations and graphs are given for elution type of countercurrent distribution analyses which enable one to predict the elution pattern and the degree of separation of a mixture of substances with a given number of stages and applied transfers assuming constant partition coefficients and Nernst's law of independent distribution. Advantages of this type of separation procedure and possible applications for research on cellulose and lignin are set forth. Preliminary work on the fractionation of lignin sulphonates and estimation of molecular weight distribution is discussed.

Determination of Salt Cake Loss at the Brown Stock Washers. Presented by Peter Taranoff, St. Helens Pulp & Paper Co., St. Helens, Ore.

First of all it might be desirable to say that this control method is not unique with St. Helens Pulp & Paper Co. Inquiries show

that almost all kraft mills with brown stock washers use similar control methods throughout the Pacific Coast for determining their soda losses. The thing that prompted this short report is that after our company installed its three-stage brown stock washers last Spring and the technical service group was called upon to determine the soda losses, we could find no mention of an accepted method in the routine control methods of TAPPI. We resorted to time-consuming tests using uranyl zinc acetate and at the same time we attempted correlation charts with a conductance meter. Although the latter method was by far the easier in our initial attempts, we did not obtain satisfactory correlation. Some mills, we understand, get excellent results with conductance-type apparatus.

As in all testing, the accuracy hinges directly on the amount of effort taken to obtain a representative sample. We found from experience that a grab-sample taken once very 24 hr. did not give satisfactory results. This was due to the variation in operation. We are relatively new at operation of the brown stock washers and these variations were extreme. Consequently we were applauded when low loss results were obtained and reprimanded when the losses were high. To improve our results, we then sampled 24 times a day from the high-density brown stock conveyor placing the sample in a tightly sealed can. This then gave us in addition to our soda loss our average consistency for the day from the last washer.

The following steps are then taken using the 24-hr. sample which is thoroughly mixed. Two 50-gram samples are weighed out accurately to the third decimal place. One sample is placed in a drying oven held at 105°C. for future consistency and sample weight calculations. The other sample is placed in a nickel crucible and ashed over a good gas flame or over an ignition type furnace. We have obtained good ashing over an electric furnace. The sample can be left to ash while other duties are performed in the laboratory. The ash is then cooled and carefully treated with hot water to dissolve all soluble salts. This mixture is then filtered through a No. 1 Whatman filter paper with thorough washing and the filtrate is received in a suction flask. A few drops of methyl orange are added and the solution is titrated with a hydrochloric acid solution of known normality. We use 0.5 *N* hydrochloric acid. The amounts of acid used are recorded to the nearest 0.1 ml.

When the sample placed in the drying oven at the beginning of the test is thoroughly dry, it is weighed and the weight recorded. The calculations using a 0.5 *N* hydrochloric acid solution are as follows:

$$\frac{(\text{ml. acid used})\ (0.5\ N)\ (142/2000)\ (2000)}{(\text{g. moisture-free wet pulp})} = \text{lb. } Na_2SO_4 \text{ per lb. moisture-free pulp}$$

Iodate Test for Sulphur Dioxide in Stack Gases. Presented by Gordon K. Bonham, Anacortes Div. of Coos Bay Pulp Corp., Subsidiary of Scott Paper Co., Anacortes, Wash.

The objective of this work was to provide the acid plant operators with a simple device for determining sulphur loss in stack gas and to obtain data to evaluate tower performance after conversion to ammonia base.

Concentration of sulphur in the stack gas was recorded hourly by determining the volume of gas necessary to react with 5.00 ml. of $N/8$ KIO_3. These data were an excellent guide for modification of the initial conversion equipment and for adjustment of acid making variables to economize sulphur.

1. This test showed the ammonia tower to be extremely sensitive to flow changes.

2. Careful adjustment in operating conditions and minor modifications in the initial conversion resulting from routine use of this test produced a savings of 7 lb. of sulphur per ton.

3. This test proved it is possible to convert a Jenssen tower to ammonia base and consistently keep the stack gas sulphur loss to less than 2 lb. of sulphur per ton.

4. The solutions and apparatus for this test are conveniently located and take a minimum of the operator's time.

5. This test produces reliable results for SO_2 concentrations too small for accurate Orsat analysis (i.e., between 0.07 and 0.30% SO_2).

Total Solids in Kraft Black Liquor. Presented by Lloyd A. Nault, Chemical Engineer, St. Regis Paper Co., Kraft Pulp Div., Tacoma, Wash.

A rapid method for determining total solids of heavy black liquor (total solids 60 to 75%) leaving the cascade evaporators was necessary for control purposes. The usual routine methods were considered too time consuming for our purpose.

By diluting a sample of heavy black liquor 50-50 by weight, determining the Baumé and temperature, the total solids were read directly from a previously prepared chart. The chart reading multiplied by two gave the total solids of the sample. To check this method, a sample of black liquor was put on a stainless steel wire cloth in a low form weighing bottle and oven dried to constant weight. This was done to insure consistency of the chart reading.

This rapid method was found to be reasonably accurate for control purposes. The total solids were correlated with the ammeter readings of the cascade motor drive, so that the solids in the black liquor feed to the recovery furnaces could be held constant.

The Determination of Red Liquor (Spent Sulphite Cooking Liquor) Solids by Permanganate Consumption. Presented by Erwin H. Olson, Project Chemist, Pulp Div., Weyerhaeuser Timber Co., Longview, Wash.

In any mill that depends upon the recovery of cooking chemicals for economical operation, the determination and control of chemical losses becomes an important factor. With the operation of a new process such as the Longview magnesia-base recovery system this was especially true.

The sources of greatest red liquor solids loss in our operation are in evaporator condensate and in the jet condenser effluent in evaporator room and solids that are retained in the pulp leaving the last recovery washer. The normal method for the determination of per cent solids at these two stations is by a specific gravity-temperature relationship using a hydrometer. However, inaccuracy in low solids range (1% and under) renders this test useless in determination of solids losses.

Oven drying procedures accepted by Weyerhaeuser Timber Co. for solids determinations are of little value in mill control because of a 24-hr. lag between sampling and results.

A testing procedure for determination of small amounts of red liquor solids was developed based on the ability of potassium permanganate to measure amounts of lignin and other readily oxidizable compounds that are present in red liquor. Permanganate number tests were run on samples of evaporator condensate, jet condenser effluent, and liquor retained with pulp leaving last recovery washer. Oven-dried solids were run on the same samples. From the resulting data curves were established for each of the three mentioned cases. From these curves solids losses could be determined by permanganate number test on a specified amount of sample.

The test was easily adapted in the mill and has been useful in the operation of the recovery washers and evaporators.

The Volumetric Determination of Beta and Gamma Cellulose. Presented by Fred R. Foley, Puget Sound Pulp & Timber Co.

Beta and gamma cellulose in pulp is conveniently and rapidly determined by the volumetric method but, since the values obtained are sometimes low as compared with gravimetric values, a study was made to determine whether volumetric values could be brought into accord with those obtained by the gravimetric method. The approach to the problem was based on the premise that the cellulose-potassium dichromate conversion factor derived from the oxidation of glucose by potassium dichromate may not hold for beta and gamma cellulose. Samples of beta and gamma cellulose were isolated and their oxidation equivalency in potassium dichromate determined. The factors thus obtained were used to calculate beta and gamma cellulose from volumetric data for a wide range of pulps. The values for beta cellulose were then compared with values obtained by the gravimetric method. The values for gamma cellulose were verified by showing that their totals with alpha and beta cellulose values approached the expected total of about 99.9%.

The theoretical factor, 0.1375 gram of cellulose per gram of potassium dichromate, may be used for pulps of over 95% alpha cellulose content, but for pulps of 80 to 95% alpha cellulose the factor for gamma cellulose was found to be about 0.147. For beta cellulose the theoretical factor (0.1375) holds for pulps of over 87% alpha cellulose content, but for pulp of less than 87% alpha cellulose the theoretical factor is too low and a factor on the order of 0.144 should be used.

For routine analysis, the volumetric method using the factor 0.1375 yields satisfactory results if the values obtained for gamma cellulose are increased by 7% for pulps of up to 95% alpha cellulose content, and the beta cellulose values are increased by 5% for pulps of less than 87% alpha cellulose content. No correction is necessary for pulps of more than 95% alpha cellulose.

A Method of Evaluating Dyes for Mill Use. Presented by Edward T. Parker, Crown Zellerbach Corp., Camas, Wash.

This method is used to routinely evaluate new dyes submitted by the various manufacturers in the field for applicability to our papers and to determine their fastness characteristics on our pulps.

Interpretation of the various test results gives information concerning relative tinctorial strengths, resistance to light ("fading"), resistance to leaching by water ("bleeding"), and chemical resistance. A catalog of dyes is built up which gives definite information as to the hues of the various dyes and also is useful in preparing color matches.

The method has proved to be valuable in evaluating dyes for se in grades of paper which have severe specifications for dye as ness. It has also proved of value in determining the most fi ient dye for a purpose on a cost per ton of paper stock basis.

hicago

At the regular meeting of the Chicago Section on January 3, Ray Frase of Addison-Semms Corp., Racine, Wis., ad- ssed the group on the subject of "Palletizing in the Paper ndustry."

Charles Krebs of Atlas Boxmakers, Inc. was in charge of e meeting and the speaker was introduced by E. C. Berg of Carton Co.

Mr. Frase pointed out that the expendable paper pallet, a w -cost lightweight packaging medium for unit loading, was sult of wartime demands. He stated that the pallet is able of supporting up to 30,000 lb. per 9 sq. ft. Mr. Frase her pointed out that the Addison-Semms people do not ll pallets but they operate through their licensees.

Mr. Frase further stated that you can make a good pallet t of most any kind of board but that corrugated board is st. Mr. Frase pointed out that the pallet is built up of lumns made from fluted single-faced board, convolutely nd and glued. These columns are glued to double-wall rugated medium for the pallet deck. Columns are de- ed to support individually 3000 lb. minimum compres- n. An 8-in. column with a 4-in. core will support 10,000 compression. The placing of columns under the deck st be adjusted to the types of lifting equipment in the field. he Addison-Semms Corp. works very closely with lifting uipment manufacturers on this point.

A bottom runner joining the posts gives more strength to ne finished unit particularly to a buckling strain. A double- ecked pallet, Mr. Frase stated, gives even more strength. roper application of banding is necessary for correct loading pallets in boxcars. He pointed out that there are three ays of buying pallets: (1) complete knockdown, (2) double nner assembled, and (3) complete assembly.

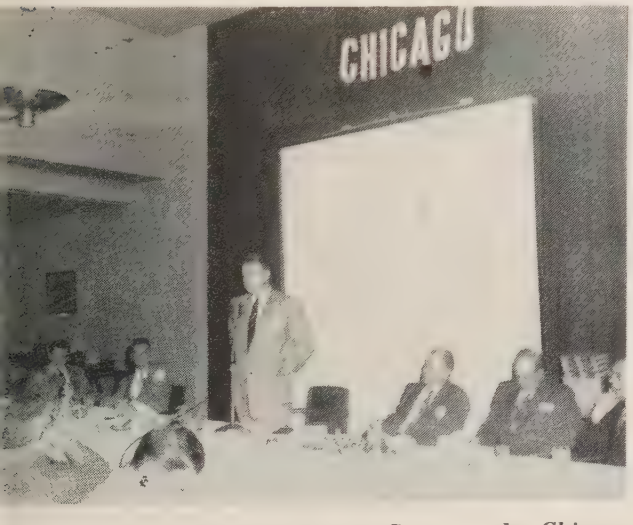
Mr. Frase pointed out that anything that handles similarly multiwall bags can be successfully handled on pallets.

Moving pictures were shown of typical palletized units on ne job. Applications ranged from paper in the sheet and ll through washing machine tubs, automobile radiators, mmunition, and even 4000-lb. loads of lead metal.

Mr. Frase stated that a new development was a knocked wn "U-Make-It" pallet. In this case, the columns are rnished in scored unglued lengths.

Typical questions and answers were as follows:

Q. What happens when the floor for storage is uneven?



y Frase of the Addison-Semms Corp. at the Chicago Section Meeting

A. With an average load of 2000 lb., any one of the posts or columns will support the load. However, if stacking is more than two high, the floor should be leveled with two by fours or similar materials.

Q. What happens to the pallets if the floor is wet or the roof leaks?

A. It has been demonstrated that wet lap pulp has too much moisture for successful palletizing. However, the palletized load will stand any moisture condition that a corrugated box will stand.

Q. What happens to pallets under sheer tension as in the shifting of a load in boxcars?

A. In this application, large diameter posts must be used but proper car loading procedure must also be applied. It is extremely important that the loads are tightly placed together in the longitudinal direction of the car. It is not so important that they be placed tightly in the lateral direction.

WARREN R. PRICE, *Chairman*
Publicity Committee, Chicago TAPPI

Empire State

(Eastern District)

The Eastern District of the Empire State Section met at Milfrank's Restaurant, Glens Falls, N. Y., on Jan. 15, 1953. The principal speaker was Prof. Edward C. Fuller of Champlain College, Plattsburg, N. Y. Sixty-five individuals were present. Robert E. March of the Marinette Paper Co., Fort Edward, N. Y., presided as chairman. Professor Fuller was introduced by Grant Cole of the Diamond Match Co., Plattsburg, N. Y. A summary of Professor Fuller's talk on "Atomic Energy" follows:

Atomic power is produced by the splitting apart of large and complex atoms into smaller and less complex ones. All atoms are composed of protons, electrons, and neutrons. Each proton carries a unit of positive electric charge and each electron a unit of negative charge. Neutrons carry no charge. Because every atom is composed of an equal number of protons and electrons, matter is electrically neutral. A proton and a neutron have approximately equal mass but have about 200 times the mass of an electron.

The protons and neutrons in a given atom are crowded together in a very tiny nucleus approximately the size of an electron. The electrons form a sort of cloud around the nucleus, the cloud having a diameter about 100,000 times the diameter of the nucleus or of the individual electrons so atoms are mostly empty space.

When a moving neutron hits a uranium-235 nucleus, the nucleus flies apart in fragments roughly half as heavy as the original nucleus. One to three neutrons traveling at high speed are also produced. These high-speed neutrons do not affect other uranium-235 nuclei. If each neutron can be slowed down before striking another uranium-235 nucleus, the splitting process is repeated and the number of nuclei split per second multiplies rapidly since the fission caused by one neutron usually gives rise to more than one neutron. A chain reaction results. To prevent an explosion, some of the neutrons resulting from fission must be captured before they strike more uranium-235 nuclei. By controlling the rate of neutron capture, the rate of fission can be controlled.

The total mass of the nuclear fragments and the neutrons produced by fission is less than the mass of the neutron and the uranium-235 nucleus which collided before fission. This loss of mass results in the liberation of an enormous amount of energy. It is this energy which the atomic engineer tries to remove from the nuclear reactor as heat.

In an atomic reactor there is a tremendous flow of neutrons in all directions. Neutrons can enter the nuclei of the atoms of almost any element. When they do so, the element frequently becomes radioactive and changes into a new element. For this reason, materials which are used to construct the reactor have to be very carefully chosen or they will disintegrate into new substances after a while and be useless structurally. Also, the reactor has to be surrounded by thick walls to shield the operators from the lethal radiations which are produced during fission. The liquid which is circulated through the reactor to remove heat also becomes radioactive and may endanger the lives of the operators.

To get the heat out of a nuclear reactor and to utilize it in a steam boiler, a liquid alloy of sodium and potassium metals is used. It leaves the reactor at about 660°. Because it is radioactive, it is circulated through a shielded heat exchanger where it gives up its heat to another separate circulating system of sodium-potassium alloy which does not become radioactive from its proximity to the first stream of alloy. This second stream of hot alloy is circulated through a boiler to generate steam.

Twenty pounds of natural uranium will yield 51,800,000 kw.-hr. of energy. At a price of $35 per pound, the fuel cost for atomic power is only 0.013 mill per kilowatt-hour. The major cost for atomic power arises from the large capital outlay required to build the reactor, the heat exchanger, and the boiler of special design.

Empire State

(Northern District)

Seventy-five members and guests of the Northern District of the Empire State Section met on Jan. 15, 1953, and heard W. Gallay, Research Director, The E. B. Eddy Co., Hull, Que., discuss the validity of some of the assumptions held commonly in the pulp and paper industry.

Under the title of "What Holds Paper Together?" Dr. Gallay discussed the status of our present knowledge of the chemical constituents of which the pulp fiber is composed, the structure of the fiber, and the various views held on bonding. The subject of the strength development of pulp was particularly emphasized by the speaker. Dr. Gallay stressed the necessity of an open approach to these problems with a re-examination of our present concepts.

The need for greater knowledge of these basic factors underlying papermaking, and for expanded research on these problems was emphasized by Dr. Gallay.

RICHARD J. MURTAUGH, *Secretary*

Empire State

(Metropolitan District)

The Metropolitan District held its regular dinner meeting at Fraunces Tavern on January 13, 1953, with about 90 members and guests in attendance. As usual routine business was quickly disposed of under the direction of Chairman Paul Haggerty and the meeting then turned over to a panel discussion on paperboard with Lew R. Ayers of the Piermont, N. Y., mill of Robert Gair Co., Inc., as moderator.

The first speaker was Edward F. Manoque, vice-president and superintendent of Gibralter Corrugated Paper Co., North Bergen, N. J. He described in detail the refining operations at his mill and noted interesting observations made through experiments with jordans and disk refiners. He stated that jordans used alone required excessive horsepower per ton of stock processed and that single disk refiners if used only while reducing the power requirements proved about equally expensive because of high maintenance costs of the disks. Further test runs showed that the most efficient stock preparation from both quality and cost viewpoints resulted from a combination of the two coupled with good cleaning of the stock. The best treatment apparently is treatment in the disk refiners followed by jordans.

The second speaker was Joseph T. Loomer, Assistant Technical Director, Robert Gair Co., Uncasville, Conn. Mr. Loomer's talk "Factors in the design of a stock cleaning system for a folding box mill" follows:

Mr. Chairman, members of TAPPI: The subject which your committee asked me to speak on is probably the biggest single problem in board today. I don't intend to go into great detail on stock cleaning systems but merely hit the high spots in attempting to cover this subject.

To those of you not familiar with board manufacture, the folding grades and jute are made of from 80 to 100% waste papers. Undoubtedly you have seen the classifications of waste papers given in the price listings of the various trade magazines. Some Classifications are Hard White Shavings, Soft White Shavings, Mixed, Corrugated, Box Cuttings, etc. All of the mills, as well as the National Association of Waste Paper Dealers, define these grades. However, in times of scarcity these definitions often become meaningless. Usually as prices rise in the waste paper market the quality goes down.

Actually, stock cleaning should start with the waste paper vendor. At the present time as in all businesses the best packs come from responsible dealers. They can control the sorting and packing to deliver a fairly uniform grade of waste. However, when waste paper is packed and handled indiscriminately and then shipped to the mill, trouble is usually in the offing.

In addition to the waste paper delivered to the mill we usually have included in it, and at no extra charge, cellophane, rubber bands, excelsior, garbage, girdles, stockings, and even dead animals. There is a story that one of our mills received a barber chair right in the middle of a bale of waste. I can't vouch for that story but during the last war somehow or another some 50-mm shells got dumped in the breaker beater in a bale of waste. These lodged in the backfall holes, and when they were discovered the beater went down while the State Police and the maintenance men gingerly removed them. The shells were live ammunition. On the somewhat lighter side we also have had in the waste paper money, stocks and bonds, radio scripts, and diamonds. The various junk removal points in the mill usually have their score of adherents hopefully searching for treasure.

With such an assortment of nonboard-making materials, you can appreciate the difficulties involved in designing a system to clean waste paper. The amount or quantity of these nonfibrous materials is a variable. We cannot definitely give certain furnishes or certain grades of waste a definite junk or grit content or for that matter even an average junk or grit content. This confuses the stock cleaning picture as obviously the stock cleaning system should be designed to handle the dirtiest stock that the mill might use.

Stated in this manner, the job of stock cleaning certainly appears even difficult to start. However, let's look at some actual practices in board mills. First let's classify the objectionable material in waste paper stock. Such a classification might be as follows:

1. Odorous materials—chemical, garbage, anything that might impart an obnoxious odor to the finished board.
2. Staining materials—waxes, dyes, asphalt oils, grease, etc.
3. Light dirt or floaters—cellophane, rubber bands, wood, rags, excelsior, etc.
4. Heavy dirt, anvils, iron, paper clips, sand, plastics, money, etc.

Odorous Materials

At the present time odorous materials in waste paper must be considered in the light of prevention rather than cure. Our best method of combating them is to inspect before the material is allowed to be pulped. I know of one mill that had a sad experience with benzine hexachloride bags that got into their furnish. The overcoming of odor is difficult and so far the only weapon is pre-inspection. One of the most irritating sources of odor is some printed newspapers. You have, undoubtedly, noticed that the ink is not sticking to your newspapers very well today and also it apparently smells "fresh of the press." Unfortunately this fresh of the press smell, or the good smell of printer's ink may be nothing but oils in the ink either rancid or on the way to becoming rancid. Again the only answer is pre-inspection, or deinking or washing.

Staining Materials

At the present time the staining materials in waste paper are much in the same category as the odorous materials. Pre-inspection prior to pulping apparently is the only safeguard. You can all recall that during the war most of the board you happened to notice was loaded with asphalt spots. In a great many cases these asphalt spots would be invisible when the board was made but as time went on they "developed" and became visible. A great deal of both work and money have been spent attempting to solve this problem. Indications are that the solution is near at hand.

Having passed over lightly two categories that the mill at the present time can't do much with, let's look into the categories that we've had a little more success.

Some years ago attempts were made to dry clean waste paper. Waste was processed through a sorting line, then a railroad duster or large tumbling barrel and finally to a shredder. The loose dirt shaken from the waste by the action of the duster was removed from the plant. More often than not it was carefully swept off the floor and subsequently dumped into the pulping operation. Dry cleaning waste paper in the board mill was costly and consequently has fallen into disrepute. I know of no mills today that are dry cleaning.

In the past ten years the emphasis on stock cleaning has been on cleaning in the wet or pulped state. Usually the cleaning begins directly in the filler pulper.

The original pulper for the filler stock was the breaker beater. The breaker beater was usually equipped with a ragger and sometimes a junk remover. Extraction of stock was on a continuous basis through 1-in. holes in the perforated backfall. The breaker beater is largely being replaced by the vortex type pulpers as represented by the Hydropulper of Shartle and the Fibrepulper of Downingtown. These pulpers are equipped with raggers, jun

movers, and an extraction plate with holes from 1 to 1/4 in. in meter.

These pulpers, being equipped with raggers and junk removers, for the first visible evidence of the removal of unwanted materials. We have only to look at the rags and the junk and definitely state how well the equipment is working. At this point I would like to interject the thought that the efficiency of a cleaning system should not be judged by what the system removes but by what it doesn't remove from the filler stock. This statement may seem a bit obtuse but remember that what has been removed from the filler stock is gone, you don't have to worry about it, but what remains in the stock is what can do damage. Since we have no way of knowing how much junk was in the stock to begin with, we shouldn't become too overjoyed at what was removed as it is entirely possible that for every pound of unwanted materials removed four pounds were not. At this point, I might also mention that the tests devised for determining the unwanted material in paper stocks are our second biggest headache. We have not yet been able to devise accurate tests, and on the ability to measure depends our ability to improve.

But to return now to the pulpers, the ragger will remove rags, paper bands, cellophane, wood, excelsior, etc., the junker will remove quite a bit of heavy metal and water-logged wood. It must be remembered, however, that whatever the ragger and junker doesn't remove goes into the stock discharged from the pulper. We can point out here our rather nebulous theory of "uncontrolled disintegration." This theory applies to any piece of stock preparation equipment. Its statement is fairly simple and is as follows. The main object of any piece of equipment in a board mill is controlled treatment of the papermaking fiber. Along with the cellulose fiber, we have unwanted materials, and the equipment changes it in size, shape, or form, we have uncontrolled disintegration. Let me cite an example. We have a pulper with a ragger and a junk remover. The pulper is also equipped with an extraction plate with say 1/4-in. holes. We know what we undesirable material that isn't removed by the junker or ragger must ultimately be reduced in size until it can pass through the small extraction holes. This must be true or else the tub of the pulper would gradually fill up with undesirable materials incapable of being removed by the ragger or junk remover just waiting to be reduced in size. This actually happens in some cases of board mill operation. It is not uncommon sometimes to shut a pulper down after two days' operation to clean out the tub. By restricting the size of the extractor plate holes, we have found the pulper to disintegrate unwanted materials. This reduction in size can only make any attempts at stock cleaning at a later date more difficult. It is almost axiomatic that the unwanted materials must be kept in as large a size as possible. This, of course, is easier said than done. The rate of disintegration of any pulper is dependent on the type of stock, the temperature, and the rate of extraction. Uncontrolled disintegration is definitely affected by the rate of extraction. The pulpers have a tub capacity of say 2000 to 3000 lb. of stock. Their rated capacity is possibly 200 tons per day. At this demand the retention time is about 8 min. At a 100 ton per day demand the retention time is 16 min. Bales of news and corrugated weigh at times 800 to 1200 lb. One bale is, therefore, equivalent to 50% of the contents of the pulper tub. It can be pulped in 16 min. The bale size versus tub size is too large for uniform pulping. Only by uniform pulping can we count on uniform stock cleaning. To recapitulate the pulper section of this report, consider the following points:

1. Operate at a high temperature.
2. Operate at a low rate of extraction when possible.
3. Add stock uniformly and continuously to the pulper.
4. Suit the extraction hole size to the type of stock, the rate of extraction, and the temperature of pulping.

To cite one test on a vortex type pulper operating at 188 tons per day on a folding grade furnish, the amount of material removed by the ragger and junker in pounds was as follows:

	Wood	*Cellophane*	*Unclassified*	*Paper*	*Total*
Junker	33	1.38	1276	69	1379.38
Ragger	4.4	26.5	2150	2243	4423.9

Note: Unclassified includes baling wire.
The junker removed 7 lb./ton undesirables and 0.3 lb./ton paper.
The ragger removed 11.6 lb./ton undesirables and 12 lb./ton paper.
The pulper removed (ragger and junker) about 19 lb./ton undesirables and 1 lb./ton paper.

It is quite obvious that the pulper and its accessories can be an important item in stock cleaning if selected properly and operated without overloading.

From the pulper the trend in stock cleaning seems to differ in opinion. Some mills process the stock directly through centrifugal cleaners such as the Vortrap, Dirtec, or Hydrofuge. These cleaners are designed primarily to remove the grit on heavies such as sand, glass, metal, etc. The manufacturers usually rate these pieces of equipment in tons such as one unit will handle 50 tons per day at such a consistency. To our way of thinking this system of rating is inadequate; it doesn't tell the whole story. Suppose we have a unit capable of passing 50 tons of stock per day at such and such a per cent consistency. By actual tests, depending on the type of stock, the grit content might vary from 3 to 30 lb. per ton or the over-all content in this case from 150 to 1500 lb. Suppose the piece of equipment was 80% efficient in grit removal this would give us a residue of 30 to 300 lb. in over 50 tons or 0.6 to 6 lb. of grit per ton. Obviously the 6 lb. of grit per ton is not as good as 0.6 lb. per ton. Equipment must be rated on its basic function as we'd love to have a piece of equipment that would guarantee less than a half pound per ton of grit in the finished stock. In selecting the number of centrifugal cleaners to be used let their tonnage capacity be a guide, but only a guide, the grit content of the process stock must be the criterion.

From these centrifugal cleaners the stock is now processed over or in screens such as the Johnsons, Reener, or Classifiners. Once again these screens are rated on a tonnage basis which means exactly nothing. The quality of the finished or screened stock should dictate the size screen holes as well as the number of screens to be used. There seems to be magic in the 1/8-in. hole size for screens. This again is in the whistling Dixie realm. In the vortex type pulper, the stock so produced only had 6.5% that would not pass a 10-cut screen. And of this 6.5%, possibly only 3.25% would not pass a 1/8-in. hole. Thus we would have to screen as rejects in our system of say 100 tons 6.5 tons on a 10-cut screen and 3.25 tons on a 1/8-in. screen.

If we presume that the difference between the above was 3.25 tons and this contained objectionable material we have introduced a tremendous quantity of potential punch marks. This, of course, is oversimplification but again it must be pointed out that the screen hole size employed should give you the quality stock you desire even if it means a greater number of screens. Usually, if the system of screens is not up to capacity, the mills and the manufacturers are quite prone to increase the hole size rather than the number of screens.

This excellent reasoning, however, leads us again to another semi-impasse. If the screens are large-sized holes we won't have many rejects and these we can afford to throw away. However, we won't have the type of stock we require either. If we reduce the hole size and increase the number of screens to give us the type of stock we need, we can't afford to throw the rejects away, and they must be reclaimed.

In many mills these rejects are collected, passed through some type of disintegration equipment such as a refiner, jordan, or disintegrator pump and then over a tailing screen. If this situation occurs in your mill choose a disintegrator that will only defiber the paper stock and not the wood, cellophane, etc. And for the tailing screen make sure it has the finest size holes of all the screens employed in the system.

The screened stocks can now be treated through a secondary set of centrifugal cleaners. In this respect the Centricleaner of Howard Smith is causing a great deal of speculation since presumably it can remove lights. Operating on this screened stock might be the best plan for its introduction in board mill cleaning systems.

Supplementary cleaning mechanisms are, of course, the in-line permanent magnets. These can do an excellent job of protecting equipment although the amount of metal removed is small. Small centrifugal cleaners on the machine probably serve as the final chance for the removal of unwanted material and it is entirely possible that some day they might make the elimination of the machine screens possible.

I find now that perhaps I've rambled on quite a bit more than I intended to. Unfortunately, the time allocated was too short to present a detailed discussion of some of the points I wanted to cover. However, thanks for bearing with me, and if there are any questions I can answer, I'll be happy to do so.

W. R. Willets, *Recorder*

Southeastern

The Southeastern Section met in Charleston, S. C., at the Fort Sumter Hotel on Friday and Saturday, Jan. 23 and 24, 1953. A social hour was held starting at 6:00 p.m. followed by dinner at 7:00 p.m. There were 112 in attendance.

The meeting was opened by Glenn C. Kimble, Union Bag and Paper Corp., Savannah, Ga., Chairman of the Section. C. A. Shoudy, West Virginia Pulp and Paper Co., Charleston, S. C., extended a gracious welcome to those present on behalf of his company.

The speaking program was built around three excellent papers. The first paper on "Instrumentation of Recovery Furnaces" by G. R. Upson and T. C. Johnson, Union Bag and Paper Corp., was presented by Mr. Upson. The second paper was given by Reavis Sproull of Herty Foundation Laboratory and had the unusual title of "Behavior of Southern Kraft Pulp at Negative Freeness." The third paper was by J. A. Van den Akker of The Institute of Paper Chemistry who discussed "Principles of Beta Ray Gage Control of Basis Weight."

Mr. Kimble then announced that the Nominating Committee for officers for the coming year would consist of Dr. Kimble, Union Bag and Paper Corp., Karl Guest, National Container Corp., Wilson F. Brown, University of Florida, William Ebersole, Macon Kraft Co., and Robert Stoertz, West Virginia Pulp and Paper Co.

The Saturday morning session began at 9:30 a.m. and consisted of a panel discussion of the evaluation of unbleached kraft pulp. The moderator of the panel was Loren V. Forman of the Scott Paper Co. The panel membership and main discussion topics were as follows:

I. "Degree of Cooking," R. R. Chase, Union Bag and Paper Corp., Savannah, Ga.
II. "Laboratory Refining," Raymond S. Hatch, Hudson Pulp and Paper Co., Palatka, Fla.
III. "Making of Handsheets," Malcolm Pineo, Brunswick Pulp and Paper Co., Brunswick, Ga.
IV. "Testing of Handsheets," J. A. Van den Akker, Institute of Paper Chemistry, Appleton, Wis.

Although no mill tour was arranged the management of the West Virginia Pulp and Paper Co. made special arrangements for those who wished to see their mill to visit it on Friday, January 23. Special guides were provided and a number of the members took advantage of the opportunity.

WILSON F. BROWN, *Recording Secretary*

Lake States

The third Lake States Section meeting of the 1952–53 season was held at Appleton, Wis., in the Conway Hotel at 6:30 p.m., Jan. 13, 1953, with approximately 125 persons attending.

This meeting was devoted to engineering, with "Stainless Steel in the Pulp and Paper Industry" as the subject of the after dinner speech by F. A. Guba of Carpenter Steel Co., Tube Div., Union, N. J. This timely subject was sufficiently interesting to draw an excellent attendance even in the middle of January when travel conditions are uncertain.

Mr. Guba outlined the desirable properties of stainless steels which are responsible for their successful performance under severe operating conditions in pulp and paper plants. He discussed the various types of corrosion which stainless steels must withstand, and then presented data on the composition, particular advantages, and best usage of the various types of stainless steels. (Mr. Guba's paper will be published, when received, at a later date.)

L. A. Moss, *Secretary*

LETTERS TO THE EDITOR

Critical Speeds, Vibration, and Roll Balancing

To the Editor, *Tappi:*

At the Engineering Luncheon Meeting which I attended with you and others, the discussion was on the selection of new subjects for next year's Engineering Conference. As machine work increases and as the speeds approach the 2000-ft. mark on standard grades with a stronger possibility that even this high figure will be exceeded before many months, the question of rolls at the higher speeds and balance has become more and more important to manufacturers. The main point is that there are many factors governing the balance of rolls for high-speed operations and especially on the wider machines. Some of these would be diameters, weight of rolls and in some cases, the actual materials that are used plus the various mechanical means that are now in use for such balance purposes.

This would be a complex subject to analyze and discuss but it might have some interest.

ALLAN HYER, *Vice-President*
Bagley & Sewall Co.
Watertown, N. Y.

To the Editor, *Tappi:*

Please refer to your letter of November 26 to me enclosing a copy of a letter from Allan Hyer with reference to the Engineering Division of TAPPI doing some work on critical speeds, vibration, and roll balancing.

In line with your suggestion, I referred this to J. B. Gough and am enclosing his letter to me giving his views on this subject.

I believe Mr. Gough has covered this very fully and there is very little that I can add to his remarks.

GEO. H. PRINGLE, *Vice-President*
Mead Corp., Chillicothe, Ohio

Dear Mr. Pringle:

With reference to R. G. Macdonald's letter of November 26 to you, enclosing copy of a letter from Allan Hyer, Vice President of the Bagley & Sewall Co., suggesting the above subject for review, analysis, recommendation, and presentation by the Engineering Division of TAPPI at the Conference later in the year, I believe that this problem does warrant the action suggested by Mr. Hyer, especially in regard to table rolls and formation now that paper machine speeds are increasing so very rapidly, and widths to some extent, especially in the "fine" paper field.

Such action could be divided into two parts, as follows:

Part 1. A review of already published data, analysis, equations, and formulas, and especially the latter, so that a compact and most authentic condensed summary of such formulas can be presented for ready reference and use, together with a definition and the significance of the various variable factors involved, and the particular units of measurement to be used and covering all the simple and likely cases to be met with in actual practice, such as rigid or self-aligning bearings, on single span with two bearings only, and also with a cantilever portion at one end, all these with and without a single rotating pulley or flywheel (of definite weight and moment of inertia at any variable distance from one of the two bearings.

Preferably, these formulas should also include, as a variable, the modulus of elasticity = E and state these values for steel, bronze, aluminum, and Monel, and also their unit weight, as all these metals are now in very general use as table rolls.

Although the first principal critical speed is the one generally sought and given, the second and higher critical speeds should be given some consideration and mentioned, as well as the two minor critical speeds, of any (?), at 50 and 70.7% of the first principal critical speed, and at least some statement included in regard to them.

All of the above factors and variables, and additional ones also, have been quite fully considered, analyzed, and solved by various very competent authorities and their work has been published in very numerous technical papers and text books, etc., so that it is quite unnecessary for any of it being repeated or extended now by either TAPPI or even the ASME

wever, a review, condensation, and simplification of these lable data would be valuable and of definite assistance to engineers in the paper industry, both those in the mills d in the paper machinery manufacturers, plants, and it ld be made by someone who is both an engineer and a e competent mathematician, preferably a university pro- r who has himself done some work on this particular lem and is able to judge as to the degree of any approxi- on that may have been involved in the various available ions which, however, are in close agreement.

Part 2. I believe I am correct in stating that all the retical solutions available are based on ideally perfect itions (except for a very small primary disturbing mass), as absolutely homogeneous metal, perfectly straight, true, ylindrical rolls and zero bearing clearance, as well as no ior source of vibration, or of sympathetic vibration, none hich assumptions are attainable in actual practice; I believe it is more than likely that relatively few rolls, in aper industry, will be found to be operating at, or near, heoretical first principal critical speed, or above same, al- gh many rolls may actually vibrate. However, it would advisable to check my statements with some machinery ler who has much more opportunity to make these calcu- ns and observe the results in actual practice.

The above case is somewhat similar to the "slender" strut, olumn theory of Euler, which includes a factor to make an oximate allowance for certain practical and more or less oidable errors and a departure from ideally perfect con- ns; and it may be that the very small primary disturbing which is assumed in the critical speed theory, and which ults in the first principal critical speed, does not cover the tire case and that a relatively badly bent shaft, or out of und roll, or loose bearings, etc., may actually result in a mewhat different and lower critical speed, or even one of the nor specific ones at 50 and 70.7% of the normal first princi- l critical speed.

A relatively few simple experiments with two or three dif- ent diameters, different stiffnesses and lengths of table lls, with bearings of minimum and maximum radial clear- ce, etc., and at various speeds, would confirm and greatly l in the acceptance and greater use of the most advisable ailable formulas, especially if some of these rolls are excep- nally straight and true, the others are in a rather bad and nt condition, as is sometimes the case, and if the experi- ents are carefully conducted in collaboration with a repu- ble machine builder. At least one brass and one aluminum or onel roll, duplicates of one of the steel rolls, should be ecked, and maybe one of the grooved or dandy roll type.

Of course, the action of the loaded wire will be to dampen suppress any vibration and thus constitute an additional fety factor.

J. V. Gough, *Consultant*
Mead Corp., Chillicothe, Ohio

the Editor, *Tappi:*

I have your letter of December 17, and you have certainly vered a lot of ground in handling a casual suggestion. I ow now why the TAPPI organization clicks.

This is a very interesting subject to many of us in the anufacturing business, and I think you are correct in re- ring it to one of the Engineering Division committees.

Allan Hyer, *Vice-President*
Bagley & Sewall Co.

ouquet

the Editor, *Tappi:*

Thank you very much for the publications that you sent during the past few years while I was in the armed vices. Your magazine, *Tappi* was my only hold to my mpany position and the pulp and paper industry.

(Signature withheld)

EMPLOYMENT SERVICE

Positions Wanted

E188-52. Mill Manager desires change. Capable of taking full charge of operations as manager or equivalent executive position. Broad practical experience in the manufacture of papers, medium quality boards, production of kraft, sulphite, and groundwood pulps and paper and converted products. Engineering graduate.

E214-53. Recent graduate Chemist of Norwegian College and Pulp and Paper School at Grenoble, France, now in the United States, desires position in pulp or paper mill.

E215-53. Chemist. Married. Experience in general mill problems, process and technical control, felt and wire problems. Presently employed.

E216-53. Paper Mill Superintendent. 20 yrs. practical experience making all grades of cylinder and fourdrinier fine papers and light weight specialties. Assume full responsibility for production, quality, and maintenance. Married. Age 40.

E217-53. Container Superintendent and former Division Chemist with 12 yrs. experience in board mills and converting plants. Now employed. Desires comparable position with a progressive company. Will consider production, sales, or technical position.

E218-53. Graduate Chemical Engineer, now employed, desires position as Assistant Manager or General Superintendent. 25 yrs. industry experience: 14 yrs. as Sulphite Superintendent, including bleaching kraft and sulphite, modern systems, engineering, maintenance, and labor negotiations.

Positions Open

P278-53. Young technically trained man in 30's for pulp sales service work. Location, New York City.

P279-53. Paper Chemist, with not less than two years' paper manufacturing and/or coating experience to work on development and application of chemicals and paper coatings. Fine opportunity with old established chemical manufacturer located in large eastern city. Please write fully about yourself and your salary requirements.

P281-53. Paper Mill Engineer with several years' experience in the manufacture of southern kraft pulp and paper wanted for research and development position in Connecticut. Some travel involved but no sales. Salary open.

P282-53. Paper Mill Chemist with several years' experience in the manufacture of sulphite and southern kraft pulp and paper wanted for research and development position in Connecticut. Some travel involved but no sales. Salary open.

P283-53. Chemist with minimum of two years' experience in laboratory and paper mills for the development of chemicals and processes for deinking paper, pitch control, coating, etc. Midwest chemical manufacturer.

P284-53. Chemical Engineer. Excellent opportunity for a young graduate engineer with several years' experience or equivalent graduate study, in a newly established technical department of a modern kraft liner board mill. Duties will involve design, process analysis, and pilot work. Chances for advancement are excellent. Location southeast. Please give details in first letter. All replies held in strictest confidence.

P285-53. Paper Chemist. At least 2 yrs. experience in paper manufacturing and coating for work in development and application of chemicals and paper coating. Fine opportunity with established chemical firm in large eastern city.

P286-53. Research and development laboratory near San Francisco has several openings for young professionally-trained men for work with paperboard, shipping cases, and folding cartons.

P287-53. Designer, with engineering experience. For design of production equipment and plant layout work. Paper coating plant, Newton, N. J.

P288-53. Technical Service Man. 23–35. College graduate, preferably of a pulp and paper course, and some mill experience to develop new and better pigments for the use of titanium dioxide in paper and to assist customers in solving troubles that may arise. Some travel. Position can lead to direct sales. Company located in Delaware.

E289-53. Young Chemist for research. Good education essential. 1 to 2 years' paper experience. Exceptional opportunity, progressive New England mill. Our personnel know of opening. Reply fully including salary requirements.

E290-53. Chemist wanted for development work on combining synthetic rubber latices with paper making fibers. Experienced man preferred. Excellent opportunities in small established organization in rural area. Well equipped laboratory and pilot equipment.

Analysis of Rosin Size

Revision of TAPPI Tentative Standard T 628 m-43

(THIS STANDARD IS UNDER THE JURISDICTION OF THE NONFIBROUS MATERIALS TESTING COMMITTE

This method deals with the analysis of those rosin sizes made ordinarily by reacting rosin with an alkali. Separate procedures are given for paste size, dry size, and size emulsions. The procedures do not apply to the analysis of colloidally protected sizes, or those containing added ingredients, such as waxes or oils.

It is usually desirable to express results as percentages of the original material and also of the total solids—i.e., on the "dry basis."

APPARATUS

Aside from the usual laboratory apparatus, the following are required:

1. *Electric drying oven*, thermostatically controlled to maintain a temperature of 105 ± 1°C. It is advisable also to have under the lower shelf an auxiliary heating coil controlled by a separate switch (in series with a rheostat, if necessary) adjusted so that starting from a temperature of 105°C., an oven temperature of 112 to 115°C. is attained in 15 min. after the auxiliary heater is turned on.

2. *Flat glass or metal weighing dishes*, diameter 50 mm., depth 12 mm. (aluminum is preferable).

3. *Light filter* (optional). This is required for the determination of free rosin in certain paste sizes by the titration procedure only and is a combination of Eastman Kodak Co. No. 52 Wratten (in "C" glass) and Corning Glass Works No. 397 Aklo filter. These filters are mounted in a box so that the Aklo filter is closest to the light source in the box and the bottom of the filter combination is 2 in. above the top of a 60-watt frosted electric bulb. The Aklo filter serves to absorb the heat emitted by the light source and thus protect the Wratten filter.

REAGENTS

A. *Acid-Free Ether.* Wash a quantity of diethyl ether with sodium carbonate solution and then several times with water. Test the prepared ether with a moist piece of sensitive blue litmus paper, which shall not change color when completely submerged in it for 15 min.

Note: The presence of peroxides in ether constitutes a safety hazard as serious explosions have resulted from laboratory work with ether containing peroxides. Test for their presence as follows: Mix 5 ml. of an aqueous solution of benzidine (Eastma Kodak No. 33), saturated in the cold, with 5 ml. of a saturat NaCl solution. Add a few drops of very dilute, freshly prepar ferrous sulphate solution (a particle of $FeSO_4$ the size of a pi point dissolved in 5 ml. of water). Then add 3 to 5 drops ether to this mixture. The development of a clear blue color tion after a few minutes indicates the presence of peroxides.

B. *Neutral Alcohol.* If necessary, neutralize 95 (by volume) ethyl alcohol with a small amount of a coholic KOH. Then test with a piece of sensitiv blue litmus paper, which shall not change color whe completely submerged for 15 min.

C. *Alcoholic KOH solution*, approximately 0.5 *N*. Dissolve 33 grams of KOH in 1 liter of 95% (by volum ethyl alcohol. Filter off any insoluble carbonat and store in a bottle protected from CO_2 of the air b means of tubes containing soda lime.

D. *Alcoholic KOH solution*, 0.1 *N*. Pipet 100 m of the 0.5 *N* alcoholic KOH into a 500-ml. volumetr flask and dilute to 500 ml. with neutral ethyl alcoh Standardize against 0.1 *N* HCl, using phenolphthalei indicator.

E. *Hydrochloric acid*, 0.1 *N*, accurately standar ized.

F. *Hydrochloric acid*, 0.5 *N*, accurately standar ized.

G. *Methyl orange indicator solution*, 1 gram p liter.

H. *Phenolphthalein Indicator Solution.* Dissolv 5 grams of phenolphthalein in 500 ml. of 50% alcoh Neutralize by adding very dilute alkali cautiously until faint pink color appears, then just remove the col with a drop or two of approximately 0.01 *N* acid.

I. *Anhydrous isopropyl alcohol*, neutral to mois sensitive litmus paper.

J. *Isopropyl alcoholic KOH solution*, approximatel 0.5 *N*. Dissolve 33 grams of KOH in 1 liter of a hydrous isopropyl alcohol. Filter off any insolub carbonates and store in a bottle protected from C of the air by means of tubes containing soda lim Standardize against 0.5 *N* HCl, using thymol blu indicator.

K. *Thymol blue indicator solution*, 1%.

Note: The last two reagents are required only for the dete mination of free rosin by the titration method.

PASTE SIZE

Rosin size in paste form normally contains 50 to 80

lids. Frequently water will partially separate out standing and care is required to obtain a representa- sample.

mpling

If the material is supplied in drums, heat the drums til the size is melted, guarding against dilution and s of moisture. Agitate thoroughly and withdraw proximately equal portions from 10% of the drums of el batch number. Thoroughly mix the samples and moisture-tight quart glass jar with the composite.

If the material is received in a tank car, heat the car til the size is melted and collect four samples by ring through the dome of the car a rod to which is ched a wide-mouthed bottle or other suitable ainer closed with a stopper to which a wire is at- ed, enabling the sampler to collect the sample at y designated level. Collect samples at four different s: 1 ft. below the surface, 1 ft. above the bottom, d at two equally spaced levels representing the second d third fourths of the car. Thoroughly mix the mples and fill a moisture-tight quart glass jar with e composite.

As an alternative method, tank cars may be sampled ng unloading by collecting four samples from the scharge line representative of each quarter of the r's contents.

eparation of Sample

Stir each laboratory sample well to insure thorough ixing. If separation of water has occurred, warm e size until with additional stirring it becomes uni- rm, taking care to avoid loss of water.

oisture and Volatile Matter

Weigh 1 gram of the original sample (to the nearest 5 mg.) into a flat weighing dish. An aluminum dish preferable since, because of its conductivity, the dish arms up faster, resulting in more efficient puffing and ster drying of the size. Place the dish containing e sample on the lower shelf of the oven adjusted to 05 ± 1°C. Turn on the auxiliary heater for approxi- ately 15 min. This procedure brings about a rapid eating of the sample which causes it to puff up and dry ry rapidly. The oven temperature should reach 112 115°C. by the end of the period required to accom- ish puffing of the size. After the first 15-min. period, move the dish to an upper shelf in the oven. Turn f the auxiliary heater, which will allow the tempera- re to drop gradually to 105°C., and continue the ying for 30 min. longer. Cool in a desiccator and eigh. Replace the dish in the oven on an upper shelf nd dry for an additional 15 min. Cool and reweigh. the second weighing shows a loss of more than 0.5 g., repeat the drying at 105°C. for 15-min. periods. the third or subsequent weighing shows an increase lue to oxidation), use the minimum weight in the lculations.

If the auxiliary heater is not available, dry for 1 hr. 105°C. and then repeat for 0.5-hr. intervals until nstant or minimum weight is attained.

Calculate the percentage loss as moisture and volatile atter; also the percentage of dry solids. Duplicate terminations should check within 0.1.

Free Rosin

Two methods are given for determining the degree of saponification of rosin. These methods are based on extraction and titration, respectively.

The extraction method is more time consuming and with this method there is a danger of hydrolysis of some of the combined rosin, giving high results. The extraction method determines free, or unneutralized, resin acids, plus all of the unsaponified esters and neutral material soluble in ether. The fraction determined by the extraction method is reported as extractable free rosin.

The titration method is faster, but assumes a knowledge of the acid number of the original rosin. It determines the free resin acids and by calculation includes only that portion of unsaponified esters and neutral materials originally associated with the uncombined resin acids in the finished size. The fraction determined by the titration procedure is reported as titratable free rosin.

1. *Extractable Free Rosin.* Weigh approximately 5 grams of the sample (to the nearest 5 mg) into a 100-ml. tared beaker; dissolve by stirring in 10 ml. of *neutral* ethyl alcohol, adding the alcohol slowly to prevent formation of lumps; transfer to a 250-ml. separatory funnel (*A*); and rinse the beaker three times with a total of 40 ml. of acid-free ether, and finally with several portions of water, not to exceed 35 ml. total, adding the rinsings to the separatory funnel. Mix thoroughly by gentle shaking, avoiding violent agitation which might result in a difficultly separable emulsion.

Let the layers separate and draw off the lower water layer into a second separatory funnel (*B*). Extract this water layer with 25 ml. of acid-free ether, draw off the water into a third separatory funnel (*C*), and add the ether extract to that in funnel *A*. Wash the combined ether extracts in funnel *A* with two 25-ml. portions of water, adding the wash water to the solution in funnel *C*. Transfer the ether extracts in funnel *A* to a weighed Soxhlet flask.

Finally extract the total wash water in funnel *C* with 25 ml. of ether, first using the ether to rinse funnels *A* and *B*. Discard the water layer in funnel *C*. Then wash the ether extract still contained therein with 25 ml. of water. Draw off and discard the water and transfer the ether extract to the Soxhlet flask containing the main ether extract. Evaporate the ether by means of a water or steam bath; then place the flask in the oven at 105 ± 1°C. and dry for 1 hr. Cool in a desiccator and weigh. Repeat the drying for 0.5 hr. intervals until a constant or minimum weight is obtained. Calculate the extracted material to a percentage of the original sample and report as extractable free rosin.

Note: Rotate the flask frequently during drying to break the surface so the moisture can be liberated more rapidly. Addition of 10 ml. of alcohol to the rosin aids in the drying. Long duration of heating may result in oxidation of the rosin with a consequent increase in weight.

Caution: Because of the explosive hazard attending the use of ether, procedures involving its use should be carried out under a hood with adequate ventilation away from open flames and exposed heating elements. Be certain that the ether is free of peroxides (*see* Reagents).

2. *Titratable Free Rosin* (*1*). This method is based on the titration in nearly monochromatic light of a

rosin size solution in combination with an indicator. The light is obtained by means of a filter whose transmission band is nearly the same as the absorption band of the indicator in alkaline condition. The indicator is thymol blue, which changes color at a pH range of 8.0 to 9.6. (Titration with phenolphthalein in normal light is satisfactory with pale rosins.) Thymol blue in acid condition transmits nearly the entire spectrum and thus appears colorless or pale pink. In an alkaline condition, a strong absorption band appears, thus producing a blue color. In place of noting the usual color change, the end point is noted by observing the point at which the light intensity is sharply decreased. Complete absorption of light will not be obtained because the transmission band of the light filter and the absorption band of the indicator in alkaline condition are not identical.

Weigh 4.0 to 4.5 grams of the size (to the nearest 5 mg.) into a 250-ml. beaker. Dissolve the size in 100 ml. of neutralized anhydrous isopropyl alcohol by adding the alcohol a few drops at a time and stirring it in until a smooth semiliquid is obtained which can be diluted with larger amounts of the alcohol without the formation of lumps. Add exactly 0.5 ml. of 1% thymol blue indicator solution and titrate with 0.5 *N* isopropyl alcoholic KOH solution over the Wratten filter.

The color after the addition of the indicator is yellow-green. As the addition of alkali progresses, the color changes to a darker green and finally there is a sharp decrease in the amount of light transmitted through the solution. This is taken as the end point. The color range will vary, depending on the color of the rosin used in the size, but the sharp decrease in the amount of light transmitted through the solution will be apparent.

Calculation:

$$\% \text{ titratable free rosin} = \frac{\text{ml. } 0.5\ N \text{ KOH} \times 0.173 \times 100}{\text{grams of sample}}$$

Notes: (1) The above calculation assumes a rosin acid number of 162. The factor 0.173 is obtained by dividing 28.06 (the number of milligrams of KOH in 1 ml. of 0.5 *N* solution) by 162. If the acid number of the rosin from which the size was made is known to be different from 162, the factor should be changed accordingly.

(2) A value approximating that determined by extraction under Extractable Free Rosin above may be obtained from titration results by the following calculations:

Let A = % free resin acids
B = % nonacids in original rosin
C = % extractable free rosin
D = acid number of original rosin

then,

$$A = \frac{\text{ml. } 0.5\ N \text{ KOH} \times 0.151 \times 100}{\text{grams of sample}}$$

$$B = \frac{(185.5 - D) \times 100}{185.5}$$

and

$$C = A + B$$

Report as extractable free rosin (determined by titration).

Total Rosin

Weigh out 3 to 4 grams of the sample (to 5 mg.) and transfer to a 250-ml. separatory funnel with about 100 ml. of distilled water. Add 2 ml. of conc. HCl, then 25 ml. of diethyl ether. (This need not be acid-free.) Shake thoroughly, relieving the pressure at intervals through the stopcock. Allow the other to separate completely and draw off the water layer into a second funnel. Wash the ether layer with three 25-ml. portions of water and transfer the wash waters to the second funnel. Run the ether layer into a weighed Soxhlet flask and rinse the funnel with fresh ether, allowing it to run into the second funnel, and add 25 ml. more of ether. Shake as before and discard the water layer. Wash the ether layer with two 25-ml. portions of water. Add the ether from the second funnel to the Soxhlet and evaporate the ether by means of a steam or hot-water bath.

Dry and weigh the extracted rosin in an oven at 105°C. as described above under Extractable Free Rosin and calculate to percentage of the original sample.

Combined Rosin

This is calculated as the difference between the percentages of total and free rosin.

Unsaponifiable Material

Weigh 3 to 4 grams of the sample (to 5 mg.) into a 250-ml. Erlenmeyer flask. Add 50 ml. of approximately 0.5 *N* alcoholic KOH and boil for 2 hr. under a reflux condenser. Remove from the reflux condenser and place on the steam bath. Evaporate the alcohol to a volume of approximately 15 ml. Cool and transfer to a 25-ml. separatory funnel. Rinse the flask three times with a total of 40 ml. of acid-free ether, and finally with several portions of CO_2-free distilled water totaling 100 ml., adding the rinsings to the separatory funnel. Proceed as in the determination of free rosin, with one modification: before adding the ether extracts to the weighed Soxhlet flask, wash with an additional 10 ml. of water. Draw off the water layer and test by adding a drop of phenolphthalein. If, as indicated by a pink color, sodium soaps are present, wash with successive 10-ml. portions of water until no reaction with phenolphthalein is obtained. Finally dry the ether extract, weigh, and calculate the weight of unsaponifiable matter to a percentage of the original sample.

Ash

Weigh approximately 1 gram of the sample (to the nearest 0.5 mg.) into a weighed platinum crucible. Place the crucible in a round hole cut in the center of a thick piece of asbestos board. The hole should be large enough to allow the lower half of the crucible to extend below the board, which is used to keep the burner flame from igniting the vapors produced. Heat cautiously with a gas burner until all volatile matter has been driven off. Increase the temperature and ignite until practically all carbonaceous material is burned off. Finally incline the crucible at about a 45° angle on a clay or fused-silica triangle, heat to a dull red, and rotate the crucible until all the carbon has been burned away. Cool in a desiccator and weigh. Calculate the percentage of ash found.

Note: Complete combustion of the carbon can be facilitated by moistening the cooled ash with a few drops of water, drying on the steam bath, and continuing the ignition. The water treatment may be repeated if necessary.

Alkalinity of Ash

Place the crucible from the ash determination in a 250-ml. beaker, cover with distilled water, and boil. When the ash is dissolved, cool and titrate to a pink

ior with 0.1 N HCl, using 2 drops of methyl orange ti cator. Calculate the alkalinity in terms of sodium rl onate as a percentage of the original sample.

Calculation:

1 ml. 0.1 N HCl = 0.0053 gram Na_2CO_3

Alkali

This method is based on the insolubility of sodium rl onate and sodium bicarbonate in anhydrous opropyl alcohol in the presence of rosin size.

Weigh 5 to 7 grams of the size (to the nearest 5 mg.) to a 100-ml. beaker and dissolve in 35 ml. of *neutral* hydrous isopropyl alcohol by adding the alcohol a w drops at a time and stirring it in until a smooth m liquid is produced which can be diluted further th out the formation of lumps. Place 15 ml. of the opropyl alcohol over the surface of the mixture in de r to prevent the size solution from creeping up the de s of the beaker. Place the beaker in an airtight co ainer to protect the contents from acid fumes nd moisture absorption and let it stand overnight. Fi er, using a dry No. 40 Whatman filter paper or qu valent, and wash the residue with small portions of ne neutral isopropyl alcohol (allowing each washing to drain completely) until the residue is free of rosin ze. Remove the filtrate and place a clean 250-ml. ba ker or flask under the funnel. Wash the filter paper wi h small portions of distilled water, collecting the so ution in the beaker and using in all about 100 ml. of water which previously has been boiled free of CO_2 an cooled to room temperature. Add 5 to 8 drops of ph nolphthalein indicator and titrate with 0.1 N HCl un il the pink color disappears. Record the titration (a). Then add 2 drops of methyl orange indicator and nd continue the titration until the color changes from ye low to pink. Record the total titration (b). From th titrations calculate the percentage of free sodium ar bonate and bicarbonate.

Calculations: If a = ml. of acid to phenolphthalein end point, and b = ml. of acid for total titration; then,

$$\% \ Na_2CO_3 = \frac{2a \times 0.0053 \times 100}{\text{grams of sample}}$$

and

$$\% \ NaHCO_3 = \frac{(b - 2a) \times 0.0084 \times 100}{\text{grams of sample}}$$

DRY SIZE

Dry rosin size normally contains 95 to 100% of solids. The usual physical form is a light powder or small granular particles.

Sampling

If a carload lot is to be samples, select 10 bags or packages representing different locations in the car. Open the bags, discard the first 6 in. of the dry size, and collect a half-pint sample from each bag at this level, equidistant from the side walls. Place all of the samples in a clean, dry container of 1-gal. capacity, such as a friction-top can, which can be sealed airtight. For less than carload shipments, sample 5 to 10 bags as directed above.

Preparation of Sample

Transfer the sample from the container to a clean, dry table top and mix thoroughly with a scoop or large spatula. Quarter, reject two of the diagonally opposite quarters, and remix the remaining quarters. Repeat the quartering and transfer two opposite quarters to a 1-qt. Mason jar. The entire operation should be carried out promptly to avoid change through contact with the air.

Moisture and Volatile Matter

Weigh 2 grams of the sample (to the nearest 0.5 mg.) into a flat weighing dish; dry for exactly 1 hr. at 105 ± 1°C., cool in a desiccator, and weigh. Calculate the percentage loss as moisture and volatile matter. Also calculate the percentage of dry solids.

Free Rosin

1. *Extractable Free Rosin.* Weigh 3 grams of the sample (to the nearest 1 mg.) into a 100-ml. beaker and form a paste by adding 10 ml. of *neutral* alcohol with stirring. Transfer to a separatory funnel and complete the determination as described under Extractable Free Rosin in paste size.

2. *Titratable Free Rosin.* Weigh 2 grams of the sample (to the nearest 0.5 mg.) into a 250-ml. beaker; mix thoroughly with 100 ml. of neutral ethyl alcohol and add 10 drops of phenolphthalein indicator. If the solution does not change color, titrate with 0.1 N alcoholic KOH until a reddish color is formed and then add 1 to 2 ml. in excess. Record the total milliliters of 0.1 N KOH added as A. Then titrate with 0.1 N HCl to the disappearance of the red color. Call the milliliters of 0.1 N HCl used B. Calculate from the formula:

$$\% \text{ titratable free rosin} = \frac{(A - B) \times 0.0346 \times 100}{\text{grams of sample}}$$

Notes: (1) The above calculation assumes a rosin acid number of 162. The factor 0.346 is obtained by dividing 5.61 (the number of milligrams of KOH in 1 ml. of 0.1 N solution) by 162. If the acid number of the rosin from which the size was made is known to be different from 162, the factor should be changed accordingly.

(2) If the solution turns red when the phenolphthalein is added, free rosin is absent and the solution may be used for determination of free alkali, as described later.

(3) Dark-colored samples may be titrated by use of the Wratten filter and thymol blue indicator as described for paste size.

(4) The remarks under Free Rosin in paste size, regarding the applicability of the two methods apply also to dry size.

Total Rosin

Weigh 3 to 4 grams of the sample (to the nearest 5 mg.) into a 100-ml. beaker, emulsify with hot water, transfer to a 500-ml. separatory funnel, and complete the determination as described under paste size.

Combined Rosin

This is taken as the difference between the total and the free rosin.

Unsaponifiable Material

Weigh 3 to 4 grams of the sample (to the nearest 5 mg.) into a 250-ml. Erlenmeyer flask and complete the determination as described for paste size.

Ash and Alkalinity of Ash

Weigh 1.0 to 1.5 grams of the sample (to the nearest 5 mg.) into a platinum crucible and complete the determinations as described for paste size.

Free Alkali

Weigh 2 grams of the sample (to the nearest 1 mg.) into a 250-ml. beaker; mix thoroughly with 100 ml. of *neutral* ethyl alcohol and add 10 drops of phenolphthalein indicator. (The solution prepared for the free rosin determination by the titration method may be used.) If the solution turns red on addition of the indicator, titrate with 0.1 *N* HCl until the red color disappears. Designating the milliliters of 0.1 *N* HCl required as *A*, calculate the percentage of free NaOH in the sample from the formula:

$$\% \text{ free alkali as NaOH} = \frac{A \times 0.0040 \times 100}{\text{grams of sample}}$$

SIZE EMULSIONS

Rosin-size emulsions, unless clear, transparent solutions, represent a difficult problem of sampling. Milky or cloudy emulsions or solutions from which rosin has precipitated are very difficult to sample and analyze. Such samples must be thoroughly agitated to obtain a uniform dispersion of any settled material.

Since rosin size hydrolyzes to a considerable extent when diluted with water, determinations of free rosin and free alkali are meaningless in dilute emulsions or "rosin size milk," such as used in paper mills. The determinations ordinarily made are those described below.

Specific Gravity

By means of a pipet, fill a weighed 50- or 100-ml. volumetric flask to the mark with the emulsion at 20 ± 1°C. Weigh the flask and contents to the nearest 0.1 gram. Divide the weight of the emulsion in grams by the capacity of the flask in milliliters and record the specific gravity to three decimal places.

Total Solids

Pipet 25 ml. of the sample into a weighed platinum dish. Evaporate on the steam bath to dryness, then heat in the oven at 105 ± 1°C. for 0.5 hr., cool in a desiccator, and weigh. Repeat the drying for 0.5-hr periods until the weight is constant or begins to increase. Calculate the minimum weight to percentage of total solids.

Calculation:

$$\% \text{ total solids} = \frac{\text{wt. in grams}}{\text{sp. gr. of sample}} \times \frac{100}{25}$$

Ash and Total Alkali

Ignite the solids in the platinum dish and determine the ash and alkalinity as described under paste size.

TOTAL ROSIN

Pipet 100 ml. of the sample into a 250-ml. separatory funnel. Add 2 ml. of conc. HCl and then 25 ml. of diethyl ether. Complete the extraction of the rosin as directed under paste size, except that 25-ml. portions of wash water are used.

Calculation:

$$\% \text{ total rosin} = \frac{\text{grams of rosin} \times 100}{100 \times \text{sp. gr.}}$$

ADDITIONAL INFORMATION

The principal changes in this revision as compared to the previous method are the introduction of the terms "Extractable" and "Titratable" Free Rosin, and a means of calculating (approximately) the former from the latter.

LITERATURE CITED

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Odor of Packaging Materials*

TAPPI Suggested Method T 483 sm-53

(THIS SUGGESTED METHOD IS UNDER THE JURISDICTION OF THE PACKAGING MATERIALS TESTING COMMITTEE)

The presence of foreign or objectionable odors in packaging materials which are to be used near food, drugs, etc., may be a serious matter. The determination of the type and source of the odor, and the level, is the objective of this test procedure. The most sensitive instrument presently available is the trained human nose, and the significance of test results will be directly proportional to the ability of a test panel organized for the purpose.

TEST PANEL

The test panel shall consist of a test director and four to eight members. These preferably should be scientifically trained, with some knowledge of chemistry selected carefully from those who have demonstrated an acute and discerning sense of smell, and preferably with experience covering a variety of types of odors. Nontechnical personnel, such as office girls, have proved to be excellent panel members, after suitable training. In general, the individuals of a test panel should accord with the average of the entire panel and consistent disaccord is a basis for replacement. Any member with respiratory infection should be omitted since sensitivity is thereby impaired. The senses of taste and odor are closely allied and members of the panel should also be tested thoroughly for taste sensitivity and differentiation. Taste is a useful method of detecting odors, as described under Procedure.

The references should be consulted for further information on selection and training of panel members.

* This method is suggested by the Standards Committee as being the most suitable to date. It is not, however, a TAPPI Standard. Criticisms are earnestly requested and should be sent to R. G. Macdonald, Secretary, Technical Association of the Pulp and Paper Industry, 122 E. 42nd St., New York 17, N. Y.

APPARATUS

1 *Sample Containers.* Vaporproof containers may ... necessary for sampling, storage, and holding speci... for the development of maximum intensity of ...dor. Friction-top tin cans, Mason jars, and labora... glassware are suitable. Containers shall be clean, ...y and free from odor. Aluminum foil or cellophane ...ll be substituted for any rubber gaskets or stoppers. ...mples may also be wrapped directly in foil, cello... ...ne, or vegetable parchment.

2 *Testing Room.* Detection of low levels of odor ...quires working space in which individual members ...the panel can concentrate. The room shall be free ...m plant or industrial odors and to avoid this it may ... necessary to take samples home at night. Ex... ...es of temperature should be avoided, except in ...ial cases, and all distracting influences should be ...minimized.

MATERIALS

A. *Standard Samples.* In some instances, standard ...mples, representing satisfactory and maximum per...sible levels of odor, may be set up. Maintenance ...the samples is a serious problem, since age and other ...ors may alter odors drastically. In all cases, it is ...rable to have some type of reference sample avail...ble.

B. *Water (Odor-Free).* Moisture is commonly used ... intensify odors, or develop potential odors. Nor...ally, tap water is satisfactory, except where residual ...dor or a chlorine smell is present. Distilled water is ...t always odorless. Each portion of water shall be ...melled and tasted before acceptance.

C. *Fatty Materials.* A range of substances contain...g oil or fat may be used to pick up certain types of ...dors, with identification and degree of odor deter...ined both by smell and taste. Common materials ...e mineral oil, milk chocolate, cream, and fresh, un...lted butter.

TEST SPECIMEN

The preparation of the test sample for presentation ...the panel is very important. No one standard method ... doing this is sufficient, since the type of materials ...der test and the possible odors present allow a ...de range of possibilities. A few of the methods ...hich have been used are given below as a guide; ...hers may be devised as necessary. Each laboratory ...ould develop and record the detailed preparation ...ocedure found satisfactory for specific products.

Direct Testing

Cut or tear representative samples of the packaging ...aterials to a convenient size. It is often desirable to ...en up fresh surfaces at the instant of smelling (tearing ...perboard, scraping wax with a knife, breaking open a ...ue joint, etc.).

Moistening

Water brings out some types of odors. By various ...echanisms, and especially when the product may be ...bjected to moisture, try one of the following:

A. *Breathing on Sample.* The tester exhales on ...e specimen, then smells it.

B. *Dampening.* Sprinkle the sample lightly with water, then smell. Time is sometimes required to develop an odor. Normally, the specimen is dampened, stored at 70 to 80°F., or at 100°F., in an odorless glass jar for 24 hr., then tested.

C. *Soaking.* Saturate or submerge the specimen in water for a period of time and at a temperature judged suitable for each case. Test by smelling both the water and the specimen.

III. Transfer to Oily Product

A. Place the specimen in a covered glass dish adjacent to but not in contact with mineral oil for 4 to 24 hr. at room temperature. Oil-soluble materials such as printing ink odor, kerosene, etc., can be detected by smelling the oil.

B. Prepare three sandwiches with a pat of unsalted butter between two pieces of the specimen and overwrap with parchment or cellophane. Hold for 1, 2, and 3 days, respectively, at room temperature; refrigerate for 30 min.; then taste and smell the butter. In preparing the reference samples, use odor-free parchment.

C. Place the folded sample in a watertight tray and add an inch depth of coffee cream (18% butterfat). Cover with aluminum foil, hold at 45°F. for 24 hr., then taste the cream. This procedure has been used widely for printing-ink odors, and is very sensitive. As an alternative, strips of material may be placed in a dish or flask and covered with cream. Run a blank test on the cream in a glass bottle with a foil cap.

D. Place the specimen in a covered glass dish adjacent to a piece of plain milk chocolate, and hold at room temperature for 1 to 2 days. Taste the chocolate and compare with a control.

E. Prepare a package by wrapping some commercial product, known to be sensitive to odor, with the specimen material. Hold for the desired time and temperature, then smell and taste the product in comparison with a control.

PROCEDURE

All samples shall be identified only by code numbers, including the control, and the panel director shall give the testers only the minimum amount of information prior to the test. The panel director shall give each member a set of specimens and a report form. Each tester shall work independently. Table I may serve as a procedural guide.

REPORT

A. *Unknown Odor.* Each individual panel member shall report the type of odor (oil, solvent, musty, etc.), its chemical nature, and (if possible) origin. Complete agreement by the panel on type of odor cannot be expected, but with experience, the group report will serve as valuable data.

B. *Known Odor.* When the odor is familiar, or is established, each individual panel member shall rate the coded samples numerically according to the following table:

Odor	*Rating*
Essentially none (pleasant)	1
Slight but not objectionable (neutral)	2
Moderate objectionable (unpleasant)	3
Strong (offensive)	4

Table I. Common Packaging Material Odors and Detection Methods

Material	*Type of odor*	*Test method*
Synthetic film	Inherent, solvent, plasticizer	I (24 hr. at 100°F.), III A, E
Paper and board	Inherent kraft	I, II A, B
	Musty or moldy (groundwood, old news, waste)	I, II A, B (4 hr. at 100°F.)
	Chlorinated phenol (additive for slime control)	I, II C
	Sour (decomposed starch)	I, II
Paper, coated	Volatile additives, casein decomposition	I
Glassine, coated	Inherent in coating; solvent, plasticizer	I (24 hr., 100°F.), III A, E
Ink and varnish	Oxidizing oils, plasticizer, solvent	I, III C
Adhesive joints (after thorough drying)	Solvents, sour starch, added perfume	I (fresh and after 24 hr. at 100°F.)
Wax	Oil, residual oxidized solvent	I (fresh shavings at room temperature in small container), III E (cheese, for example)

Intermediate ratings, e.g., 2.5, may be made where increased sensitivity is possible.

Note: The decision between "slight" or "not objectionable" and "moderate" or "objectionable" will obviously depend upon the product tested, the functional requirements, and the experience of the test panel. The objectionable odor level must be *remembered,* with some help from standard samples.

The individual ratings shall be tabulated and if possible averaged. The exact procedure followed shall be recorded.

C. *Taste as Odor Index.* The same reporting system shall be used on samples under Procedure III B to III E, inclusive.

Note: After all the test results are in, it is usually desirable to review individual reports in a group meeting, for educational purposes.

REPRODUCIBILITY

If the average rating is over the previously agreed rejection point (generally 2), make a check test, preferably using different panel members.

ADDITIONAL INFORMATION

This method was developed in cooperation with a committee of the Packaging Institute.

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Cereal Straw Pulping in the United Kingdom

LEWIS G. HEBBS

Historically the production of pulp from cereal straw preceded the chemical pulping of woods on the industrial scale, and straw pulps were used for newspaper when expanding consumption demands exceeded the supply of rag then available. Although early in the field straw has been displaced chiefly by wood but occasionally by other fibers such as esparto in the U. K. and straw pulp for papermaking has remained in production in a relatively few mills in the world; notably in the Netherlands, Italy, and the Argentine.

Under war conditions large quantities have been used, particularly in the U. K., but the rapid reversion to earlier imported raw materials after both the 1914–18 and 1939–45 wars would appear to refute the claims made for straw as a source of paper pulp. However whilst this experience in the U. K. could be cited as showing that straw pulping was only a wartime expedient it may be of interest to consider the background of these changes, particularly in these days of wood pulp shortage when the use of cereal straw is under frequent review in many parts of the world.

In the prewar years (before 1939) there were 41 integrated pulping papermaking mills in the U. K. producing esparto pulp by the conventional pressure cooking method using caustic soda. Esparto grass, imported mainly from the North African coasts of the Mediterranean, was a "return cargo" available at relatively low prices of the order of £3.15.0d to £4 per ton delivered in the U. K. and some 250,000 to 300,000 tons was the normal annual consumption.

The pulping plants of course varied in size but with the arithmetic mean at no more than 7000 tons of grass per mill per annum or producing about 3000 tons of pulp, it is obvious that the units were very small by modern wood pulping mill standards.

In the first years of the war, with esparto supplies dwindling and finally cut off, cereal straws were increasingly substituted as shown in Table I. These are large amounts of straw compared with the consumption (for papermaking) elsewhere in the world but represent a "wartime" effort by a number of mills otherwise starved of raw materials.

Leaving out for the moment of three "board" mills, there were now 54 paper mills with some kind of pulping equipment (as compared with the 41 "esparto" mills of prewar) and of these seven were "large" mills taking just over 100,000 tons per annum between them. The remaining 47 mills therefore averaged about 5000 tons of straw per annum or no more than 1700 tons of pulp from each plant!

Our wartime experience of straw pulping for papermaking was therefore principally in small plants built to handle esparto and it was early recognized that this was bound to involve high alkali and fuel consumption for the following reasons:

1. Straw is relatively more bulky than esparto so that a 5-ton esparto digester could only be charged with 3 tons of uncut straw.
2. Whilst esparto can be cooked with 13 to 15% of caustic soda on its weight, cereal straws required 22 to 25% of caustic soda.

Lewis G. Hebbs, Partner in Firm, Cross & Bevan, Bedfordshire, England.

Table I. Annual Consumption of Straw for Pulping in the U. K. During War Years

	Tons per annum
1941	127,000
1942	249,000
1943	303,000
1944	328,000
1945	346,000

ble II. Postwar Straw and Esparto Purchases for Pulping in the U. K.

	Straw, tons per annum	*Esparto, tons per annum*
1946	295,000	
1947	190,000	
1948	172,000	343,000
1949	86,000	361,000
1950	100,000	307,000

3. Because straw pulps are relatively "wet" and slow draining compared with esparto, less liquor could be removed from the sters within the time cycle permissible in the pulping plant sparto mills washing is usual in the digester—there are only ry few "diffusers" installed and as yet no "vacuum washers" se for this purpose in the U. K.).

4. The yield of pulp from straw from such processing was not than 33 to 35% as compared with 42 to 45% from esparto.

Surveys made at that time showed that the alkali recovery as averaging no more than 46% in mills processing straw as mpared with 78% recovery when pulping esparto. This nsiderable loss in alkali (and corresponding deterioration in ill effluents) had to be tolerated under war conditions be- use maximum pulp output was required and there was no portunity for extending the washing, evaporation, and re- very plants.

The mills were faced with further problems due to difficulty keeping their rotary furnaces burning. This followed from e high liquor to straw ratio in the digester and the increased roportion of alkali so that the ratio of organic to inorganic atter in the liquor was reduced by about 30% as compared ith operating on esparto.

The effect of lower calorific value and greater difficulty in nition was evident not only with the rotary burners but also ith the two spray-type furnaces installed in Scotland. One these, with soap-stone lining was kept burning by the addi- on of fuel oil but the other (with water-cooled walls) could not e kept in operation on straw liquors.

The question of the effect of high silica content from the raws in the recovery cycle is often raised but as far as we now there were no difficulties from this cause — and doubt- ss the large liquor losses due to poor drainage/washing con- tions contributed to this end. Further, it should be noted at the precipitated calcium hydroxide from the causticising ants was not being burned for re-use.

Pulping straw with equipment designed for esparto resulted such greatly increased consumption of alkali (both as make- o soda ash and as caustic soda) that the industry consumed most four times as much alkali as before the war, for a ightly lower pulp output at the peak period.

Under war conditions many things are possible (and are ermissible — even in mill effluents) but with esparto again vailable there was rapid reduction in straw consumption Table II) which by 1949 had declined down to one quarter the tonnage in the peak year and actually for papermaking the esparto mills the shrinkage was still greater, the mounts listed for 1949-50 being the consumption of the

able III. Typical Values for Esparto and Straw Pulps fter Conversion Into Sheets on the British Standard Machine

	Typical values for industrially produced bleached esparto pulps	*Typical values for bleached straw pulps produced with soda cooking in esparto mills*
egrees Canadian freeness	454	197
pparent specific gravity	0.45	0.74
reaking length, meters	5450	8110
urst factor	29.8	54.3
ear factor	193	146
ouble folds (M.I.T.)	20	410

The pulps were given 30 min. in the Lampen ball mill before sheeting.

Table IV. Estimated U. K. Straw Production (in Thousands of Tons)

	Wheat	*Oat*	*Barley, etc.*	*Total*
1939	1645	2003	892	4540
1943	3775	3754	2007	9536
1944	3333	3625	1992	8950
1945	2306	3800	2321	8427
1946	1967	2903	1963	6833
1947	1667	2509	1619	5795
1948	2361	2963	2027	7351
1949	2204	2995	2129	7328
1950	2606	2692	1711	7009

board mills on semipulping and some "new" or newly converted straw pulping projects.

This almost complete reversion of the esparto mills is of some interest when today's relatively high cost of esparto is considered. Before the war straw (delivered at the mill) would have cost about one half as much as esparto and throughout the war years the delivered cost (averaged over the whole country) was close to £5 per ton, only rising to £7 in 1948. By then esparto was again available at an average c.i.f. price of £14.10.0d or say £16 delivered, restoring the earlier 2 to 1 ratio as compared with straw.

However, since then the price of esparto has risen substantially, averaging £33 per ton for the first half of 1951 (c.i.f.) and with current quotations between £45 and £50, while straw has stayed at about £7 per ton delivered. In spite of this straw still remains relatively unattractive to the esparto mills because of the decreased output, increased fuel and alkali consumption, and perhaps most important of all, esparto pulp has superior characteristics for the paper grades which these mills are producing. These differences can be seen from the test results on typical industrially produced soda cooked pulps from the two raw materials, converted into sheets on the British Standard sheet machine after 30 min. beating in the Lampen ball mill (Table III). Comparison at constant beating degree (freeness) would have been preferable as is our normal practice but is not possible with these pulps of such widely different initial freeness. We are in fact comparing dissimilars which unfortunately had to be used as substitutes under war conditions.

Because cereal straw pulps do not "match" esparto this does not mean that they are without value for papermaking, but it does explain the reluctance of the esparto mills to continue with their use.

It follows that for the production of substantial tonnages of straw pulp in the U. K. an entirely new plant is required and the problems involved have been investigated by many interested parties but relatively few have proceeded to the installation stage.

The first problem is of course the assurance of an adequate supply of raw material continuing over a long period in view of the high capital cost involved in pulping installations.

For simplicity we can consider the wheat straw figures since this would be the main raw material if the industry developed, although both oat and barley straws can be used in emergencies. In 1939 when the U. K. was following a "live-stock" policy the wheat straw production was just 2,000,000 tons out of 4,500,000 tons total of straw of all kinds. During the war years when the U. K. was following a "cereal policy" and

Table V. Pulps for Board Production

	Straw semipulp	*Typical "Grade 13" wastepaper*
Degrees Canadian freeness	158	230
Apparent specific gravity	0.65	0.55
Breaking length, meters	6430	2750
Burst factor	40.0	22.0
Tear factor	119	190
Double folds (M.I.T.)	130	10

The pulps were given 30 min. in the Lampen ball mill before sheeting in the laboratory.

Table VI. Comparison of Straw Pulps from Different Processes with Typical Sulphite Wood Pulp Grades

	Typical straw pulp as produced in esparto mills	*Pulp from continuous "tower" processing with soda and chlorine*	*Pulp from neutral sulphite pressure cooking*	*"Soft"-printing type bleached sulphite wood pulp*	*"Strong" bleached sulphite wood pulp*
Degrees Canadian freeness	197	146	170	290	300
Apparent specific gravity	0.74	0.82	0.80	0.82	0.85
Breaking length, meters	8110	8520	8570	6330	8020
Burst factor	54.3	57.5	56.9	41.9	55.3
Tear factor	146	119	138	141	161
Double folds (M.I.T.)	410	800	530	110	860

The pulps have all been given 30 min. in the Lampen ball mill before sheeting in the laboratory.

the area under the plough was increased from 13,000,000 to 19,000,000 acres, the amount of wheat straw doubled and the total quantity of straw each year reached about 9,000,000 tons — as brought out in Table IV. However, inspection of these figures will show the wide fluctuations which can occur either due to weather/harvesting conditions or from the effects of "political" policy changes.

It is extremely difficult to obtain reliable figures for the amount of straw used in animal feeding or bedding/ploughing-in, but in general most "authorities" appear to be agreed that the requirement on the farms in the U. K. will exceed 6,000,000 tons per annum over the next year or two. By comparison, the 200,000 or 300,000 tons which might be consumed in papermaking is an insignificant amount but with the farm consumption equalling close to the whole production, a year of poor straw harvest could mean that a mill was either without supplies or having to pay exorbitant prices. This condition may be aggravated in a poor straw year by the farmers wishing to increase their reserves for "short-crop" held on the farm and currently estimated at about 1,600,000 tons in the U. K.

The next point is that with some few exceptions the paper mills have been located with a view to markets, water supply, ports, and similar considerations and are not well placed in relation to those straw growing areas where there is likely to be an excess over the local farm requirements. This therefore means either going to the expense of sheeting and shipping any straw pulp which is made or building a completely new integrated mill including paper machinery and the still higher capital costs thus involved make it even more imperative to be assured of a continuing source of supply.

These were among the matters discussed when it was proposed (during the war) to erect a straw pulping mill under government auspices and have since been again considered by a committee of the paper industry—in each instance thinking in terms of a modern alkali cooking mill of such capacity that it could support a large recovery unit and furnace which would be thermally efficient—with a pulp capacity of say 30,000 tons per annum or preferably more. It is perhaps unnecessary to add that such a large straw pulping mill would have to be sited so that the effluent could be discharged directly to the sea or at least tidal water. The large capital requirement, uncertainties about future raw material trends, straw supplies, and so on have so far prevented development along these lines, although such projects look more attractive in the light of recent prices for wood pulps.

An alternative approach is the production of high yield pulps using relatively low concentrations of alkali and without the complication and expense of recovery plant. Several such "semipulping" plants were started during the war years and are still running, taking the bulk of the straw now being consumed in the U. K. These pulps have received rather more chemical treatment than the earlier lime cooked strawboard, being given about 9% of caustic soda whilst passing through a tube or tower on a continuous treatment basis to be followed simply by washing and mechanical subdivision.

Obviously the waste liquor from such processing will result in a very substantial increase in the biological oxygen demand of the mill effluent making it unsuitable for release into any but the largest rivers (quite apart from the effect of the alkali residues).

Tests on such liquors have given B.O.D. values of 200 so that even a small pulp output gives an effluent equivalent to the sewage from a substantial town as far as oxygen consumption is concerned and for this reason such plants can really only be considered for installation on estuaries and sites having direct access to the sea.

These semipulps form a useful addition to board furnishes as will be appreciated from the results in Table V where their characteristics are compared with those of typical repulped wastepaper normally used for this purpose and now in insufficient supply in the U. K. About two thirds of the straw now being consumed by the industry is converted into such semipulp.

On sites having facilities for the disposal of effluents of this type it is obviously possible to follow the alkali semipulping cook with chlorine/hypochlorite treatment also with the continuous tower technique and bleached pulps are also being produced by this process from straw in the U. K. This involves the purchase of large quantities of reagents (soda and chlorine) not always readily available or alternatively the cost of installing electrolytic cells to be off-set against the conventional alkali recovery plant which is also a steam raising unit. However, the merit of this approach is of course that by avoiding the use of a recovery plant the mill capacity need not be on the large scale otherwise necessary to justify the installation of a modern spray-type furnace.

Again where such effluent facilities exist (and suitable sites are rare in the U. K.) high yield semichemical pulping with neutral sodium sulphite can also be considered and again straw pulps have been produced by this method in the U. K.

In Table VI average strength values are given for straw pulps from the three methods and for comparison also typical values for bleached chemical wood pulps all similarly beaten and sheeted.

As will already have been noted from the comparison with esparto in Table III, the straw pulps all show high tensile and bursting strengths with relatively low tear accompanying high sheet density and have given low freeness values from constant beating treatment. These may be taken as inherent characteristics in straw pulps as has been widely recognized.

A defect in straw pulps not brought out by normal laboratory evaluation is the tendency to produce small transparent specks in sheets which are heavily calendered.

The U. K. experience on the pulping of a considerable tonnage of cereal straw in my belief may be summarized as showing that whilst satisfactory pulps for papermaking can be produced from cereal straws by the three methods mentioned the pulps have slow drainage characteristics and will work "wet" on the paper machine. When used in more than very small proportions they are best suited to furnishes for relatively slow running papers such as "bank/bond" or even "glassine" type and further should be limited to papers required to have only low finish.

This, of course, means that straw pulps are more suitable as substitutes for chemical wood pulps than for esparto although in the long run no fibrous raw material substitutes for another, each being developed for its own inherent characteristics, which approach is only now beginning to be applied to papermaking from the cereal straws on any considerable scale.

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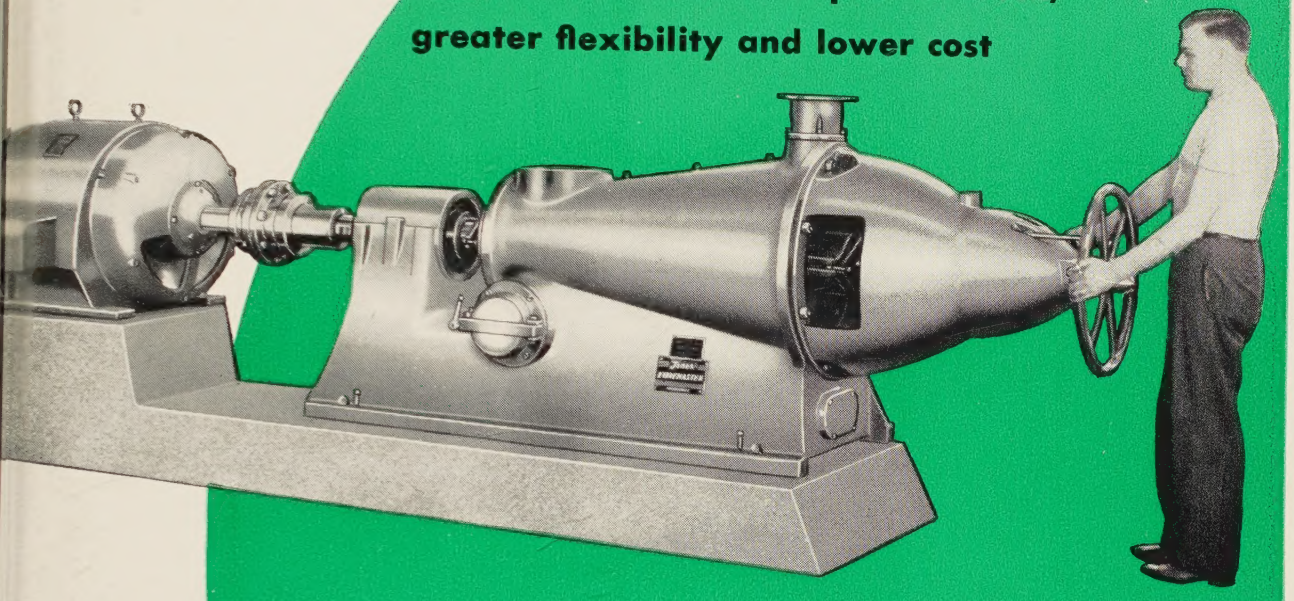

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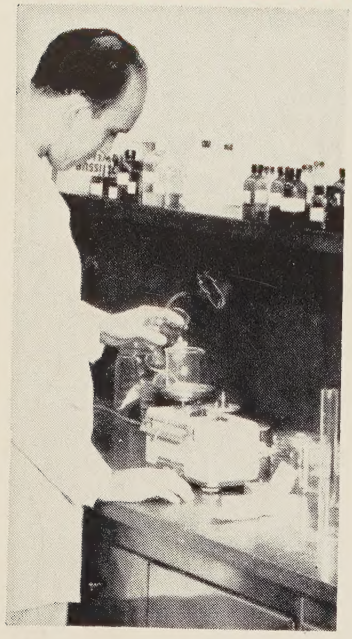

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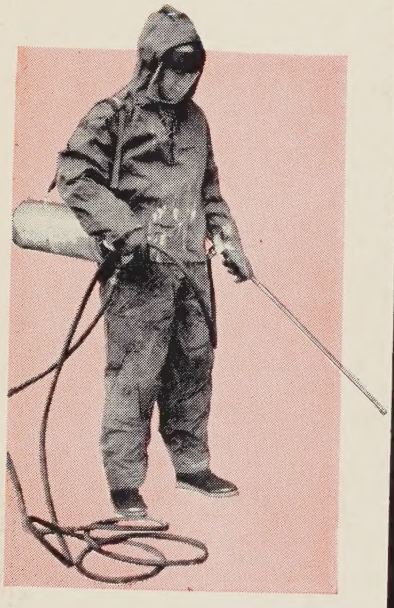

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